Undergraduate Thesis Prospectus

Creating Accessible Research Opportunities: Lowering the Barrier for Undergraduates

(technical research project in Biomedical Engineering)

Opening the Door Wider: Support for Students with Disability in the Classroom

(sociotechnical research project)

by

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.
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General Research Problem

How can educators in the United States use novel technologies to adapt their teaching practices?

In the last 40 years, Americans educators have adopted educational technologies. Educational research findings have promoted some innovations in educational technology (Shaughnessy, 2004), such as the computer and mobile phone (Grayson, 1980). While some educators have enthusiastically embraced these developments to improve lessons, others have argued that education technology is overused (Wait, 2018). Understanding how novel and traditional educational technologies are employed in the classroom is integral to evaluating their impact on students' academic success.

Creating Accessible Research Opportunities: Lowering the Barrier for Undergraduates

How can the University of Virginia engineering department create an education program to prepare undergraduates for success in research?

I am completing this project through the Department of Biomedical Engineering. My advisor is Dr. Helmke in the Department of Biomedical Engineering. This is a solo capstone project.

Participation in undergraduate research is vital for long term academic success. An undergraduate who builds relationships with faculty through research experiences is more likely to persist in higher education, especially if they are members of underrepresented groups (Chickering & Gamson, 2014; Nagda et al., 1998). Students planning to enter either industry or graduate school benefit by gaining research experience (Russell et al., 2007). The spread of COVID-19 in Spring 2020 presented several hurdles, preventing students from gaining the in-person research experience and training required for research. Wet lab research experiences were abruptly cancelled and undergraduate students were asked to leave campus. In addition, 204 of

267 (76%) of rising 3^{rd}- and 4^{th}-year students at the University of Virginia School of Engineering and Applied Science who responded to a survey indicated that their summer research programs were cancelled or delayed. Students in their 1^{st} and 2^{nd} years are disproportionately impacted by these challenges because they often have not yet built the professional network and foundational knowledge necessary to gain access to research positions. These barriers are amplified for students who did not have access to research experiences prior to joining the University community. As a result, the challenge in the coming semesters is to design online activities to lower barriers to entry into research opportunities, especially for 1^{st}- and 2^{nd}-year undergraduates.

We will organize a novel interactive workshop series titled Starting an Undergraduate Research Experience (SURE) to teach basic research methods and support feelings of belongingness among undergraduate engineers. The goal of these workshops is to provide underclass engineering students with knowledge and skills that will connect them with future in-person research experiences and reduce the barrier to entry into high-level research. The program incorporates the positive benefits of a structured course when introducing undergraduates to research (Heemstra et al., 2017; Hu et al., 2008; Lopatto, 2010). In addition to conveying useful information, similar course-based research experiences provide equal opportunity to students from all socioeconomic backgrounds and thus increases the equity and inclusivity of research as a whole (Bangera & Brownell, 2014).

While undergraduate research experiences are valuable for increasing success, it is difficult for students to become involved in research through current methods. Previous programs have failed to account for the imbalances in opportunity cause by socioeconomic status (Agholor et al., 2017; Cutright & Evans, 2016). Furthermore, current approaches lack the multifactor approach we will provide. Some research involvement programs utilize peer mentors to guide inexperienced participants in learning lab skills or discussing shared experiences (Agholor et al., 2017; Chesler & Chesler, 2002; Cutright & Evans, 2016; Lim et al., 2017; Rodriguez et al., 2019), but fail to assist students during the transition into research. Assistance during this transition is crucial to reinforce the student's sense of belonging and to answer personal questions regarding the student's research interests and involvement. Other peer-mentored programs discuss the steps required to become involved in research (Allen & Eby, 2008; Lopatto, 2010), but fail to provide the hands-on training to improve successful student outcomes. Experience using basic laboratory equipment, such as pipettes and scales, will boost the student's confidence while providing tangible skills to highlight on the student's resume or application. Finally, student-taught classes have been studied in a variety of disciplines (Freeman & Steefel, 2016; Smith, 2017; Tollefson et al., 2018), but few of these programs are conducted specifically in a research setting. Applied research requires problem solving capabilities and hands-on experience, which are important factors ignored if students are passively learning content in a traditional classroom environment.

We will employ several underutilized methods to achieve the goal of creating this workshop series. We will host an hour long, biweekly, student led workshop series that covers topics such as "Who Does Research and Why?", "How Does One Use Research to Ask and Answer Questions?", and "How Does an Undergraduate Get Involved in Research?". These topics will provide students with information on how to become involved in research and how to align their current research opportunities with their long-term goals. In contrast to previously used methods, SURE will utilize a combination of large workshops and small group discussions to maximize student engagement. The large workshops will involve all participants and will demonstrate a crucial skill or concept, while small group activities will delve into the details of the topic covered in the main session in an environment that fosters participation. Additionally, student teachers readily relate to participants as they have recently experienced the difficulties the participants are solving (Bauer & Bennett, 2003), increasing probability of successful outcomes for the student (Robnett et al., 2018). SURE's utilization of both small group discussions and student leadership in a research focused course have not been attempted and offer substantial benefits for students. Student research participation and feelings of belonging will be collected in pre- and post-workshop surveys to assess workshop viability in improving successful student outcomes.

Success in achieving our goals will formally create SURE as an extension of the School of Engineering and Applied Science. Further, we will have created the infrastructure to produce a long-term program to benefit students indefinitely. Importantly, SURE will generate research involvement opportunities for students of all socioeconomic backgrounds that were previously non-existent or inaccessible for aspiring undergraduate researchers.

Opening the Door Wider: Support for Students with Disability in the Classroom

In the U.S. since 2010, how have teachers, advocates of the disabled, and public education administrators competed to determine the necessary extent of classroom accommodation for disabled students in public schools?

Students with disabilities have long struggled for their rights in the classroom. While the Americans with Disabilities Act (ADA) in 1990 required accessible learning spaces for those with both physical and mental disabilities (ADA National Network, 2020; Mayerson, 1992), some advocates argue for expanding accommodations and existing framework for students. Advocates of disabled students say they need stronger legal guarantees (Coelho, 2019), as No

Child Left Behind divided the disabilities community over the extent to which students with disabilities should be supported (U.S. DOE, 2003). Novel treatments and technologies, such as behavioral therapy and specialized prosthetics, give students freedoms in the classroom that regulations had not defined as thus have been popularized within the disabilities community (Orthopedic Appliance Co, 2019).

Researchers have investigated the efficacy of these treatments and educators' responses to them. Positive academic effects have been observed when instructors accommodate students' disabilities, such as increased retention of material and improved performance on assessments (Bettini et al., 2016; Ran et al., 2020). Other research details the improvements in students' sense of belongingness after receiving educational support for their disabilities (Lohbeck, 2020), which leads to improved academic outcomes and job readiness. Contrastingly, technology can also impede educational progress by distracting students (Tiene, 2001), particularly young students (Gurzynski-Weiss et al., 2015). While previous research has increased understanding of the role of technologies in the classroom, current research lacks experimental data to decisively correlate student outcomes to the utilized technology. As such, these findings are largely correlative and lack substantial causal evidence. A focus on meta-analysis and quantitative measures would increase validity of argued opinion and provide the data to substantiate claims regarding the efficacy of these technologies. Similarly, current research lacks comprehensive investigation into the effects of teacher bias regarding use of the technology in the classroom. Previously reported findings that assess student outcomes primarily test the effects following inclusion of the device. Additional metrics, such as teacher opinion of the device and administrative support, could provide a multifactorial understanding of the impact of each variable on successful student outcomes.

Participants include public educators who advocate for increasing accommodations for students. Many of these educators value the positive benefits of these accommodations, even with noted downsides, as they state that the accommodations create “better working environments for students of all backgrounds” (Cox & Jimenez, 2020; Strickland et al., 2020). Students with disabilities advocate for utilizing their assistance technologies to complete schoolwork and feel integrated with their non-disabled peers. These students often experience “traumatic or impactfully early life events” that influence their beliefs of increasing inclusion and student accommodation using novel technologies, a belief commonly expressed through various acts of political activism (Lohbeck, 2020; Ran et al., 2020). Parents of students with disabilities advocate for increasing use of these technologies in the classroom as current methods are inadequate and fail to “prepare [students with disabilities] for life after high school” (Mader & Butrymowicz, 2017). School administrators that oppose accommodations aim to increase consistency of student treatment and prevent potential “negative educational experiences” and distractions in the classroom (Bettini et al., 2016). Administrators are more likely to resist technological innovation than other participant groups as they argue for simplifying the already complex classroom environment and to focus more on already-proven teaching methods. Companies creating these novel solutions favor the use of these new technologies in the classroom to help students live productive lives and assimilate into classroom activities (Gilroy et al., 2018; Orthopedic Appliance Co, 2019). Not to be ignored are the company’s financial gains following successful utilization of their technologies (Gilroy et al., 2018), an important motivator in their advocation for the use of these technologies.

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