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Surviving and thriving in COVID

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Abstract

Many summer bridge or other programs focus on initiating high impact activities (Kuh, 2008) as mechanisms of relationship-building among attendants and the university sponsoring these activities. Additionally, a broad spectrum of these bridge programs are grant-funded by either state or federal funding agencies. Mentored research within a university laboratory connects the undergraduate to career insights and cultural awareness of research. COVID- has altered but not cancelled this activity over the last two years.

Keywords: *Summer bridge; STEM research; undergraduates; DOED MSEIP grant.*

1. Introduction

Summer undergraduate research and summer bridge programs for entering undergraduates are staples to initial training of college-goers to the possibilities that mentored research offers their understanding of what the profession involves, what basic or applied research involves, and provides mentoring by PhD scientists such that undergraduates develop a consideration of what a career in research could/would involve especially within tier one laboratories.

Undergraduates become aware of theory, practice, success and failure at the bench. Moreover, they see modeled for them what scientists actually do in the day-to-day routine demands of their laboratories. Conversations between mentor and student can lead to greater insights and address limiting ideas the student may have of what it means to discover new concepts or information.

The summer bridge program involving mentored research for first generation students becomes a critical component to the student's consideration of entrance into a doctoral program as a career. Among institutions which are primarily undergraduate institutions with no doctoral programs, the summer bridge programs are crucial to introducing first generations diverse students to the possibilities that research holds as career stepping stones by enhancing the entire undergraduate experience through increased relevancy, substantive meaning of a career in science (STEM) (Mogk, 1993; Lopatto, 2004, 2007).

High impact practices often suggest strong connections to student retention and student engagement as well as character development as it connects to leadership development (Kuh, 2008; AACU, 2008; Kuh & Umbach, 2004). Many four-year colleges and universities encourage a common practice of mentored undergraduate research as a student support mechanism and as a career development opportunity, especially within the sciences (Lopatto, 2007). Several studies offer well-documented findings associated with undergraduates involved in research experiences in under the guidance of laboratory principal investigators or in the classroom setting using a student-centered, problem-based approach. Likewise, studies on the effectiveness of mentored research experiences indicate several important findings, such as: 1) enhancing the entire undergraduate experience and 2) on increasing the substantive interest in entering a career in science through advanced graduate work (Mogk, 1993). Gains in self-confidence and pathways to science careers, especially among first generation, minority, and female undergraduates were documented in several studies by Lopatto (2004, 2007) and Hathaway, et.al, 2002).

In the UHD Scholars Academy program a Department of Education MSEIP grant award (award #P120A190069) enabled the establishment of a summer bridge mentored research program supporting both incoming freshmen (FTIC) and current undergraduates in their initial mentored research experience. Year one occurred during May and June 2020 during the first lockdown of the COVID-19 pandemic spanning almost all institutions of higher

education. This paper provides explanations, data-gathering, outcomes associated with implementation of a virtual mentoring bridge program. The award was received in October 2019 and involved multiple targets including: 1) freshman UpSTART programs, 2) Academic Skill Monitoring, 3) Mentoring, Leadership/Teamwork Development, 4) Mentoring, and 5) Career and Research Skill Development, which will be the focus of this paper.

Goals of the awarded grant entitled "UHD Enhancing STEM Success Through Complex Problem Solving, Preparation and Access" address STEM success program components as well as some innovative mechanisms. A primary focused outcome is to encourage, prepare and support minority STEM students, especially females. Another is to target access for first time in college entering undergraduates through summer bridge program and transition activities into enrollment. Success is targeted in all years where transitions and rigor form barriers for undergraduates with some of the success activities to include freshman UpSTART, academic skill monitoring, mentoring in small learning communities, career/Research skill development and leadership/teamwork enhancement, then finally intentional financial literacy skill development. Other targets include support of STEM females through a Women in STEM series, Women Mentoring Women workshop approach, and career development through mentored research under the guidance of PhDs.

2. Beginning Under COVID-19 Virtual Environments

The grant administration team was comprised of PI and four PhD Co-PIs (Dr. Gabriella Bowden, Dr. Mian Jiang, Dr. Ting Zhang, and Dr. Weining Feng) spanning all College of Science and Technology STEM departments at UHD. Each a subject matter expert in their field provided the depth of knowledge and experience in mentored laboratory work to excel. Each had provided mentored research experiences during academic and summer sessions to undergraduates prior to the quarantining events associated with COVID. However, none had provided virtual mentoring and as such each became experts through experiential methods.

A little bit about each Co-PIs' research is useful to best understand the magnitude of impact going virtual would present in order to reach the targets of the grant program.

Dr. Gabriela Bowden's research involved measuring the human response to bacterial pathogens, or the study of spore-forming soil microorganisms. Studies that address the impacts of environmental contaminants on microbial populations which in turn could impact humans. Usually this type of research must be completed under strict safety protocols and within laboratory onsite.

Dr. Mian Jiang's research involved the study of molecular nanowires. Specifically, participants will prepare conducting polymer-based nanowires, and nanowires from

conducting polymer/carbon nanotube composites. studies will extend the known facts of nanowires being used for mechanical devices and microcircuits into high capacity nanobattery and chemical sensing. Considering the sponging and biocompatible nature of conducting polymers, the proposed polymer nanowire sensors may represent nearly ideal detector elements since their size match that of biological macromolecules. Again, this type of research is usually always performed within a laboratory setting onsite.

Dr. Ting Zhang's research involved the study of robotics, neuroimaging, and artificial intelligence (AI) on web databases. Specifically, the cutting-edge techniques in computer science, electrical engineering, and biomedical engineering are investigated to advance interdisciplinary research approaches. This arena of research was very approachable through virtual environments.

Dr. Weining Feng's research involved electronics, power systems, measurement and instrumentation, control engineering, data communications, and networking. She has worked extensively in the area of robot manipulator dynamics and control and has brought her experiences in the areas of system reliability, failure mode, and effects of criticality analysis to both the research laboratory and her teaching classroom.

With the large numbers of highly interested undergraduate bridge and current students additional research PhDs were solicited for participation. Each received a small stipend per semester for their participation. Other PhDs brought a broad spectrum of research across other STEM disciplines including: mathematics, datascience, statistics, computer science, web development, robotics, organic chemistry, genetics, cancer research, bioinformatics, material sciences, microbiology, plant biology, and environmental biology. Each PhD mentored from 2 to 4 undergraduates per the five week summer bridge program. In keeping with the targeted support of STEM females, 12 PhDs were female and 5 PhDs were male. Of these PhDs with minority status comprised only 2 individuals. One minority male was part of the mentoring PhDs as well.

3. How Mentored Research Occurred in a Virtual Environment

This question was key to bringing all participating PhDs into an understanding of the outcomes expected for their research group/students. The question also provided some very interesting opportunities for all undergraduates as they entered into the mentored research program. The keys to successful outcomes were generated by outstanding, flexible, and creative PhDs providing the mentoring. Together in an initial meeting discussed the possibilities of what approach/es and accomplishments could be expected from the participating students. This conversation occurred via a Zoom video-conference meeting with the PI/Co-PIs and all other PhDs.

Begin with theory by offering readings of published literature in their SME areas. Generally, this is not where mentored research begins when normal "in the laboratory" conditions occur. So this was a revamped approach which provided foundational understanding of the research to be undertaken. Next, each PhD agreed to move to processes to be undertaken once back in the laboratory. In the case of Dr. Bowden's microbiology research students investigated protocols for creating agar cultures, staining, etc. In the case of Dr. Jiang's chemical laboratory, challenges to these students were to transform laboratory safe procedures into "kitchen chemistry" safe procedure that could be done in a home environment. The goal in one instance was to create a titration lab using kitchen chemistry. Both students approached the challenge from different perspectives as one student was a junior chemistry major and one a sophomore chemistry major, but both developed successful techniques. Further, Dr. Feng's students decided upon their projects and she subsequently ordered materials to outfit kits per each student. These kits were put together and sent to each students' home where they would meet with Dr. Feng virtually via Zoom and demonstrate where the project was moving. All activities took place over as five-week period.

As PI of the overall project, the role involved setting the milestones, meeting dates, mid-session presentation dates, and submission of final abstracts, posters/slideshows, and video with all members involved in the creation of the groups' achieved outcomes. These deliverables were then sent to the DOED MSEIP program director for inclusion in the summer research conference (also held virtually).

4. Holding Student Researchers Accountable

4.1. Visual Accountability

Students were asked to document both in paper format and visual formats weekly discussions occurring with each of the PhD research mentors. These were uploaded into an MS Teams area within PhD folders. Other artifacts, such as Youtube videos, other videos, websites, e.g., BLAST were also uploaded as evidence of research and skill development. Review of safety practices associated with each researcher were documented within the TEAMS data system.

4.2. Meetings Accountability

Students met with their individual PhD research mentors weekly via Zoom video-conference meeting. Zoom meetings were to be recorded and uploaded into the TEAMS environment. All student researchers were asked to work from 8 to 10 hours per week on their research projects as well as complete a Weekly Research Report form documenting current status in the project, planned activities per discussion with the PhD, and overall progress. The report forms would be upload into TEAMS for review and signatures by PhD mentors.

4.3. Orientation Meeting/s

The PI/Co-PIs and other participating researchers were asked to attend an initial orientation meeting of one hour held via Zoom video-conferencing. An overview of the general objectives of the program was provided. Likewise, weblinks to the Zoom meetings, times, and attachments were sent through email but also uploaded into the MS TEAMS environment for transparency and access by all. All meetings were recorded to ensure all could have additional access to the meeting contents for refresher purposes or in the event they could not actually attend. As part of the orientation, the PI provided a general discussion related to goals, hours needed for weekly progress, expected outcomes for student deliverables. This was necessary as each undergraduate participant would be provided a research stipend of $700 for the five-week period.

A mid-session Zoom meeting was scheduled for all participants to provide a one-slide overview of the progress within their research group. All members would have to provide speaking portions indicating they were all participating.

4.4. Deliverables

Student success was assessed via multiple measures. Deliverables were submitted to document project progress during the 5-week period of mentored research. Deliverables included 1) weekly research report forms, 2) attendance of all meetings including weekly PhD meetings, 3) DOED MSEIP abstract template produced and approved by PhD research mentor, 4) mid-session slideshow outlining progress, and 5) production of zoom video describing the cumulative accomplishments of research project/s for the 5-week program.

Participants were asked to complete a SURE Survey for Mentored Research taken from Lopatto, 2007, 2010. The survey was digitized into a Qualtric survey for ease of analyses. All participants in years 1 and 2 completed the SURE survey. Additionally, all participants were asked to complete a Leadership Survey derived from Northouse, 2019. This survey was placed in a Qualtrics framework and distributed. Approximately 50% completed this survey. An additional survey was collected investigating confidence, competence, likelihood of pursuing STEM careers, increased likelihood of finding STEM employment upon graduation, increased academic capacity due to participation in mentored research, perceived improvement in critical thinking, technical writing, and presentations, and feeling more connected to college coursework.

In late July 2020 all student produced abstracts and powerpoint posters were provided to the DOED MSEIP Program Director for review and selection of presentation as part of the Competitive Capacity Enhancement Model Student Research Conference (CCEMSRC). Four abstracts from our university program were selected to present their virtual mentored research findings. The students included were mentored under the guidance of Dr. Ting

Zhang, computer science and robotics, Dr. Connie Kang, genetics, Dr. Ling Xu, computer science and web development, and Dr. Sanghamitra Saha, bioinformatics/biology. The students performed well and learned of other models of virtual research projects undertaken by other universities with similar awards.

5. Programmatic success measurements

The DOED MSEIP targets support of STEM, STEM minorities, STEM females in particular as outcomes to be reported. Figure 1 below describes the increasing number of participants involved in the mentored research virtual programs over the first two years of the grant award.

As can be easily noticed, all participating categories are increasing over the two-year period. Also, more minorities (who tend to be first generation students) are engaging in mentored research thereby connecting them to the university, to their course of study, and to the potential to move into STEM career pathways as they graduate.

A review of participating bridge and undergraduate research students indicates continuance among a majority of those beginning initially in the virtual environment. Figure 2 describes the fluctuation in participants but also shows increases in minority participation and females.

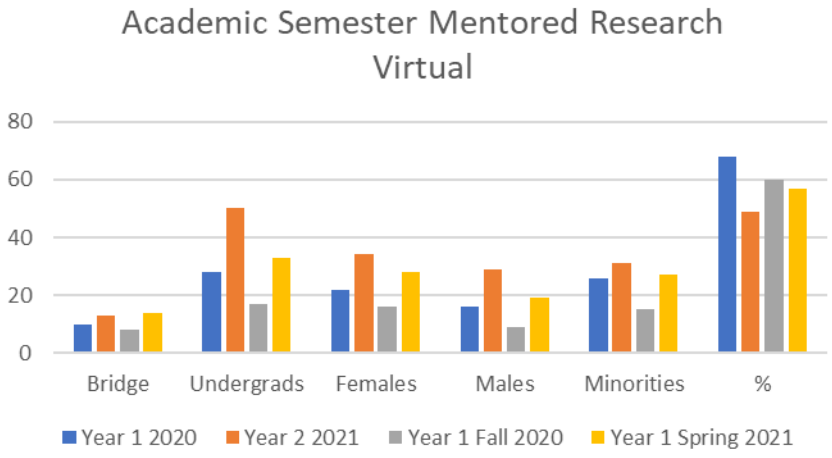

Figure 2. Participation by category in academic and summer virtual research.

6. Finding common interests for matching

Undergraduates are matched with on-campus UHD PhD research scientists within a variety of STEM lab settings. The SME PhD comes to understand the qualities/competencies and commitment the undergraduates bring to gaining deep learning of not only discipline content and skills, but also of what research is and what it can become for each of the mentees in the

pursuit of individual careers. Early mentored research students are guided by and learn from an upper division undergraduate who has worked with the PhD for some time (within the normal settings and possibly within the virtual COVID settings). As the early career research students develop expertise and competency in the lab and trust on the part of the PhD researcher, they move up within the lab setting and become perceived as a leader. Thus, student researchers are trained in skillsets and laboratory leadership is developed through this mentorship in research. Matching by common interests between PhD and undergraduate truly has long-term impact on post-baccalaureate graduate/professional program outcomes, individual ambitions, and confidence to enter STEM careers (Lopatto, 2004; 2007; Mogk, 1993). Funding support provides those engaged in mentored research a workforce connection encouraging chosen STEM research career pathways as well as transferability of the skills into the post-baccauleate workplace.

7. UHD, SA and minority research student development

Based on current demographics that Hispanics and other minorities are likely to become the major ethnic group in Texas by 2030 (Associated Press, 2004) there is a need for Texas to close the science education gap and to recruit more Hispanic students and other minorities into university STEM degree programs. A clear need exists for more minority undergraduate students across a broad natural sciences, computer and mathematical sciences, and engineering technology degree emphasis to enroll in and complete STEM degrees, thus lessening an educational attainment gap evidenced among minorities (Dugan & Komives, 2006). At UHD this includes all degree plans within the College of Sciences and Technology. The ultimate goal of increasing the pipeline of minority students, entering and completing the baccalaureate degree, is strongly connected to the need for 1) familiarity of the college experience [most are first generation], 2) pre-college academic support, 3) academic monitoring, 4) mentoring by STEM faculty and undergraduates already successful in the STEM arena, 5) broadened exposure to graduate and industry experts and opportunities, 6) research and career experiences/exposure, and 7) training in leadership development across various aspects of STEM (DOED MSEIP 2013 award #P120A130040).

Unfortunately, minority students continue to dismiss the four-year university out of fear of the unknown prior to entrance or out of a lack of understanding of expectations. Minorities, particularly minority women, continue to fail-out of first-year barrier STEM courses as a result of no substantive support services within the designated/selected content discipline, lack of adequate pre-college preparatory coursework, and/or little to no acculturation into the study hours and techniques needed to grasp rigorous, often difficult STEM content topics/knowledge as presented in first year courses. First generation minority students, in particular, have no historical, familial connections to what the collegiate expectations are for STEM students, thus have less than supportive network available to them once entrance into

the STEM degree curriculum begins. Working with the mentored research program provides foundational knowledge and experiences to minorities to begin to see or envision their potential within a STEM career.

Because UHD is an urban MSI/HSI university located in the 4th largest metropolitan city in the U.S., the mentored research development program, virtual or otherwise, provides an intentional, purposeful vehicle aimed to 1) support minority students seeking university degrees through this large university, 2) examine how and what leadership through mentorship in the research arena influences STEM undergraduates college to career readiness enhancements, impact, and degree completion (baccalaureate and post-baccalaureate), and 3) creates processes and product knowledge for other universities, both minority-serving and other, to utilize in the support of undergraduate research development positively influencing the changing demographic constituencies and leadership capacity of Houston, Texas, and the U.S.

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