2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #34956

An Initial Exploration of Engineering Student Perceptions of COVID's Impact on Connectedness, Learning, and STEM Identity

Dr. Craig O. Stewart, University of Memphis

Dr. Craig O. Stewart is an associate professor of Communication at the University of Memphis. His primary areas of research are Science Communication and Discourse Studies and has published in Science Communication, International Journal of Science Education, Research in Science Education, among other outlets.

Dr. Maryam Darbeheshti, University of Colorado Denver

Dr. Maryam Darbeheshti is Assistant Professor of Mechanical Engineering at the University of Colorado, Denver. She is the PI of a recent NSF award that focuses on STEM identity at Urban Universities. Darbeheshti's primary research is in the area of Multi-phase viscous flows in Fluid Mechanics. She also studies the factors that improve First-Year Engineering Program. Darbeheshti created the Engineering Learning Community for First-year students at CU-Denver. She is a member of ASME, the Society of Mechanical Engineers, SWE, the Society of Women Engineers, and ASEE. She serves as the faculty advisor for SWE in the College of Engineering, Design and Computing at CU-Denver.

Dr. Stephanie S. Ivey, University of Memphis

Dr. Stephanie Ivey is the Associate Dean for Research with the Herff College of Engineering and a Professor with the Department of Civil Engineering at the University of Memphis. She directs the U of M's Southeast Transportation Workforce Center and the West TN STEM Hub, and is Associate Director of the Division of Transportation and Logistics in the Center for Applied Earth Sciences and Engineering Research. Her technical research includes focus on journey to school in urban areas, transportation planning (particularly related to freight impacts), livability assessment in urban communities, and strategies to engage citizens in the transportation planning process. She has a strong record of STEM workforce and education research, with special emphasis on transportation workforce development, partnerships between industry and academia, and increasing representation of women and underrepresented minorities in STEM.

Ivey is a member of the Institute of Transportation Engineers Diversity and Inclusion Committee- STEM Sub Committee, the American Society of Civil Engineers National Engineers Week/Discover-E Task Committee and the TRB Standing committee on Maintenance and Operations Personnel. She also serves on the Federal Reserve Bank of St. Louis Transportation Industry Council, the TennSMART board and the Board of Directors for the Greater Memphis IT Council.

Dr. David J. Russomanno, Indiana University - Purdue University Indianapolis

David J. Russomanno is dean of the Purdue School of Engineering and Technology and a professor of electrical and computer engineering at Indiana University-Purdue University Indianapolis (IUPUI). Before joining IUPUI, he was the R. Eugene Smith Professor and Chair of the department of electrical and computer engineering within the Herff College of Engineering at the University of Memphis. Prior to his academic career, Russomanno was employed by Intergraph Corp., Pratt and Whitney Aircraft, and Michelin Tire Corporation as an engineer. Russomanno has secured several million dollars in extramural funding for basic and applied research, as well as for initiatives to improve the recruitment and retention of STEM students. Sponsors of his research include the National Science Foundation, the U.S. Army Research Laboratory, the U.S. Army Night Vision and Electronic Sensors Directorate, the U.S. Army Redstone Technical Test Center, and numerous sponsors from the private sector. His research interests include intelligent sensors and supporting software infrastructure, knowledge representation and inference, data and knowledge visualization, software engineering, logic programming applications, and STEM education. Russomanno received his B.E.E. in electrical engineering from Auburn University in 1986, and an M.E. in electrical and computer engineering (1989) and Ph.D. (1993) in computer engineering from the University of South Carolina.

Miriam Howland Cummings, University of Colorado Denver

Miriam Howland Cummings is a PhD candidate in the Education Research Methods program at the University of Colorado Denver. Her work focuses on applying a wide variety of quantitative and qualitative research methods to education contexts, including both K-12 education and higher education.

Mr. Gregory Edward Simon, University of Colorado Denver
William Taylor Schupbach, University of Colorado Denver
Dr. Mike S. Jacobson, University of Colorado Denver

Professor of Mathematics for over 40 years, with a keen interest in STEM Education.

Prof. Tom Altman, University of Colorado Denver

Tom Altman received his B.S. degrees in Computer Science and in Mathematics, and M.S. and Ph.D. (1984) in Computer Science, all from the University of Pittsburgh. Dr. Altman specializes in optimization algorithms, formal language theory, and complex system simulation. He has published over 75 journal, conference, and technical papers. Presently, Dr. Altman is a Professor of Computer Science at CU Denver and has been an active ABET Program Evaluator (CAC) since 2008. His current research focus is on STEM and more specifically, Engineering Education.

Dr. Karen D. Alfrey, Indiana University - Purdue University Indianapolis

Karen Alfrey is a Clinical Associate Professor in Biomedical Engineering and Associate Dean for Undergraduate Academic Affairs and Programs in the School of Engineering and Technology at IUPUI. She has been a member of ASEE since 2003.

Prof. Katherine Goodman, University of Colorado Denver

Katherine Goodman is assistant professor at the University of Colorado Denver, and curriculum lead at Inworks, an interdisciplinary innovation lab. Her research focuses on transformative experiences in engineering education. She is currently division chair of the Technological and Engineering Literacy - Philosophy of Engineering Division (TELPhE).

An Initial Exploration of Engineering Student Perceptions of COVID's Impact on Connectedness, Learning, and STEM Identity

Many STEM students were affected by the pandemic and subsequent switch to remote learning in different ways. However, one common issue is that moving from face-to-face interaction to remote interaction (e.g., Zoom) has left many students feeling detached from their STEM communities which in turn negatively affected their learning. For example, 46% of engineering and technology students at IUPUI reported "loneliness and lack of connection" as result of the pandemic and 61% agreed that "online learning is [a] difficult format for learning" [1]. In this paper, we seek to understand how the pandemic and remote learning have affected student perceptions of connectedness with their university, their campus, and their peers and classmates, so that we can more nearly meet their academic needs. By qualitatively analyzing interviews with engineering students about their experiences and perceptions of the pandemic and remote learning, we offer some initial observations of these students' perceptions of the impact of the pandemic and remote learning.

The context for this study is the Urban STEM Collaboratory, a National Science Foundation funded program that provides financial, academic, social, and career support to undergraduates majoring in engineering or mathematics who are academically well-qualified and have financial need. One of the primary goals of the project is to help participating students build and maintain a strong STEM identity. The Collaboratory includes three public urban research universities: University of Colorado Denver (CU Denver), Indiana University-Purdue University Indianapolis (IUPUI), and the University of Memphis (UofM). Participants in the program, Urban STEM Scholars, participate in a variety of activities, including summer bridge programs and an academic social networking site across all three campuses, called Course Networking (the CN), as well as mentoring, peer-led team teaching, community outreach, and other activities that vary by campus and individual student interest. Urban STEM scholars earn "badges" through the CN for participating in activities and must earn a minimum number of badges to maintain their scholarship (see [2] for more details on the Urban STEM Collaboratory).

Carlone and Johnson [3] proposed that STEM identity comprises three dimensions: (1) *competence*, or one's knowledge and understanding of STEM; (2) *performance*, or one's ability to engage in various STEM practices; and (3) *recognition*, or being seen by others and seeing one's self as a STEM person. Therefore, students' interactions and relationships with faculty, mentors, and peers are key components in developing a STEM identity [4]-[11]. Of course, with the COVID-19 pandemic greatly reducing, if not entirely eliminating face-to-face classes, meetings, and study sessions, opportunities for interaction, and the relationships that are formed through these interactions, have also been reduced.

Because the Urban STEM Collaboratory is engaged in researching students' STEM identities, we have been collecting qualitative and quantitative data on a variety of student perceptions of identity, interactions, and relationships. In particular, in semi-structured interviews conducted in Year 2 of the project (Fall 2020-Spring 2021), students were asked about their perceptions of how the pandemic has affected their connectedness to their campus and to their peers and how remote learning has impacted their learning. The scholars were also asked to comment on the effectiveness of certain program components of the Urban STEM Collaboratory in light of the

pandemic. The goal of this poster is to present some preliminary observations regarding student perceptions of how the pandemic has affected their experiences.

Method

A total of 17 Urban STEM Scholars (6 women) from CU-Denver (n = 10) and UofM (n = 7) participated in one-on-one semi-structured interviews. All Urban STEM Scholars from both campuses were invited to participate and all those who agreed to participate were included. Participants received a small monetary incentive and participation counted toward one of the badges they can earn as part of the program.

The semi-structured interviews covered a variety of questions regarding student identity and STEM identity. They also included a sequence of questions specific to COVID, which are the focus of this poster:

> How connected do you feel to [CU Denver or UofM]?
> How connected do you feel to your peers in your classes?
> How do you think that connection has been affected by the remote format of courses?
> How has the Urban STEM program been helpful (or not) in fostering a connection?
> How has the CN (Course Networking) been helpful (or not) in fostering a connection?
> What effects do you think the pandemic has had on your college experience so far?
> What effects do you think the pandemic has had on your academic learning so far?
> How do you think the pandemic may (or may not) affect your job prospects in the future? Is that something you've thought about?

For the purposes of this poster, we present a preliminary analysis of the COVID segments of these interviews. Co-authors (MC, MD, WS, GS, CS) each reviewed a subset of transcripts with the following guiding question: "How did COVID/remote learning impact engineering students' attachment to and interactions with peers? What specific problems or benefits did students identify?" We then identified key points and pulled exemplar quotes from the transcripts illustrating what seemed to be important or salient to how students perceived COVID affecting their experiences. We then reviewed and discussed our transcripts together and identified some key topics that appeared across transcripts. These topics were: problems associated with not being on campus; use of technology to build and maintain connections; drawbacks of online/remote learning; benefits of online/remote learning.

Additional quantitative data was collected and compared for the 2019-20 and 2020-21 academic years related to student participation and performance at the UofM. This data is presented in the Additional Evidence section and provides further detail on the impact of COVID on our scholars.

Not Being on Campus

One obvious impact of COVID has been that students are not on campus the way they would be otherwise. Students noted that there are fewer opportunities to meet and get to know other students when they are not physically together, that their student routines have been disrupted by not coming to campus, and their feelings of connectedness are often tied to the physical places. Regarding meeting and getting to know students face to face:

> "Because if you have those in person classes, you could definitely communicate easily with your teachers and your peers. In my classes in high school, I would make pretty good friends with people I just sit next to. But I don't have that now."

Said another student, regarding routines:

> "I feel pretty disconnected right now. I think that's due to the fact that, before all this happened, I had like a routine. I took the train all the way downtown and then walked to campus. And I had like a routine for the college. I had like, you know, it's like I had my own lunch places that I'd go to with friends like that I knew around there, yeah. And it was nice. It's like I knew the campus layout, I, you know, I was able to...I guess I sort of had like a schedule and like you know I would do repeated things."

And finally, demonstrating the importance of physical place:

> "I'm sitting in my room right now, and this is where everything happens. Every single thing in my life happens in this room, and sometimes it drives me crazy, because I don't know how to separate my work life, my school life, my personal life, my everything, my commitments. I'm sitting in my bed and I'm trying to relax, and I'm thinking about my laptop which is probably like 10 feet away from me."

Using Technology to Create and Maintain Relationships

Students mentioned that they were using a variety of platforms for communicating with friends and classmates, such as GroupMe or Discord, as well as (for some students) the CN, which is part of the Urban STEM Collaboratory program. In addition, some students indicated that they felt a good sense of connection to the peers that they communicated with through those platforms, even if the number of potential connections was limited.

> "Actually, yeah, I have connection. I've had a lot of social connections actually. We've been able to go around COVID and get together virtually, which is very very nice. And it helps mentally, 100%."

> "One of the students that was there texted in the chat, like, 'Hey, let's all make a group! Let's all make a Discord group!' So we're all -- I don't think everyone's in there, but everyone who's there, every once in a while will jump in and say something, and it feels a lot more connected that way."

Drawbacks of Online/Remote Learning

Students identified a variety of drawbacks and issues with learning remotely, with many comments indicating that they feel they are learning less or not at all. One student tied these problems to the lack of physical boundaries between learning/workspace and living space:

> "For me personally, I know some of my friends have done really well on online learning, but for me it's been a struggle to focus. I really liked having like the, kind of like, switch to disconnect from home where you get to relax, you know, watch TV and stuff, to go sit down in a lecture hall with your notebook open, looking at the professor and whatnot. I struggled trying to, you know, not be distracted by, you know, looking away or doing something else, because you can pretty much [look away or do something else while] on Zoom, right?"

Another student pointed to limitations in the technology:

> "It's a lot harder to see each other's work to see what we did and someone to help us to understand it, drawing, because the stuff we do is very hard to put into words sometimes and so you need to see it in order to understand it, and that is definitely something that we really don't get to have with this online format."

Finally, a student highlighted the issue of cheating in online/remote classes:

> "I definitely cheated on some stuff I should not have. But also, everybody was cheating...so it's like, 'Okay, do you do the honest thing and suffer, because everybody else cheated and screwed up the curve? Or do you cheat so you can be where you probably would have been if nobody had cheated?' So, it creates a huge dilemma, I think, for everybody."

Benefits of Online/Remote Learning

Perceived benefits of online/remote learning were less common than drawbacks. However, some students indicated that becoming more comfortable with online platforms was not altogether negative, even if they would generally prefer to be on campus. For example:

> "And just like yeah, that in general, like learning to like switch to online, it's been, like, not bad. It's been a tough journey, but it's been not bad like I think…I think when we get a vaccine and all the cases go down, I will want to be going back to campus, but like learning to be existing in an online environment, it's not been like a bad experience."

And one student indicated that he and his classmates had taken advantage of the ability to rewatch lectures on Zoom to facilitate effective study practices (i.e., knowledge checking and peer explanations):

> "We kind of just meet up on Zoom, and one of us will share our screens [to play the lecture], and we'll go through and if we don't understand something, we'll ask. Typically, there's someone who understands."

Impact of Program Interventions

While overall, students appear to feel less connected to their peers and see more drawbacks than upsides to online/remote learning, we did see some evidence that interventions associated with the Urban STEM Collaboratory helped students to feel more connected. For example, several students expressed appreciation for the Urban STEM Collaboratory in general for creating opportunities for engagement. For example:

> "I really think that involvement is one of the best things that we can have and one of the best parts about the Urban STEM program."

Regarding the CN academic social networking site, some students indicated that it helped them create connections across campuses:

> "CN has been helpful to make connections across all three campuses."

Finally, CU Denver students indicated that the Engineering Learning Community (ELC) associated with the Urban STEM Collaboratory at that campus was helpful in maintaining friendships online:

> "Oh yeah! Actually, the ELC, actually. I'm so happy I joined that, 'cause -- so we have a DISCORD with all of the engineers from the ELC, all the ones that wanted to join. So, we have a -- we play games with each other sometimes online."

Additional Evidence

The UofM also collected data on scholars' participation and academic performance for both the 2019-20 and 2020-21 academic years. Participation data included attendance records from the summer bridge program and regular academic meetings organized for the scholars. In 2019-20, the summer, fall, and most of the spring semester meetings were held in person while all meetings held from March 2020 until May 2021 were held virtually. Students were expected to participate in all meetings (both summer and academic year) and signed a pledge to do so when joining the program. Early alert notifications were tracked for the scholars in both years. The early alert notifications were sent to the UofM PI for all students in the program, indicating poor class attendance, test grades, or other factors that were resulting in poor performance in a course.

A marked difference was noted in participation between the two years, with 100% participation in the summer bridge and 71% attendance in academic year meetings in 2019-20 (n=17) and 83% participation in summer bridge and 60% participation in academic year meetings in 2020-21 (n=35). The percentage of students receiving early alert notifications increased from 2019-2020 to 2020-21, with 23% and 29% of students receiving alerts, respectively. In addition, 6% of scholars requested referrals for academic, mental health, or other support services in 2019-2020, and 14% of scholars requested referrals for these services in 2020-21.

Conclusion

Overall, students indicate a relatively high degree of dissatisfaction with online/remote learning and a desire to return to campus face-to-face. However, they also seek ways to maintain connections with other students virtually and to manage the challenges associated with remote learning. Because interactions and relationships are significant factors in developing and maintaining STEM identity, researchers might expect the pandemic to have negatively affected students' STEM identities. Quantitative data available from the UofM also support these findings and indicate decreased engagement and somewhat increased academic, mental, and social difficulties due to the pandemic. These preliminary observations suggest that such concerns would be warranted, but engineering students are adaptive and resourceful. Our ongoing studies, including more formal analyses of these interview data and comparisons between our first year and second year interview and survey data will further explore the impact of COVID-19 on STEM identity.

References

[1] IUPUI, "School of Engineering & Technology Student COVID-19 Transition Needs Survey," 2020.

[2] K. Goodman, S. S. Ivey, C. O. Stewart, S. O'Brien, M. Darbeheshti, W. Schupbach, and K. D. Alfrey, "Launching the Urban STEM Collaboratory," paper presented at the ASEE Annual Conference and Exposition, Virtual, June, 2020.

[3] H. B. Carlone and A. Johnson, "Understanding the science experiences of successful women of color: Science identity as an analytic lens," *Journal of Research in Science Teaching,* vol. 44, no. 8, pp. 1187-1218, Sep. 2007, doi: 10.1002/tea.20237

[4] D. Esparza, A. E. Wagler, and J. T. Olimpo, "Characterization of instructor and student behaviors in CURE and non-CURE learning environments: Impacts on student motivation, science identity development, and perceptions of the laboratory experience," *CBE-Life Sciences Education,* vol. 19, no. 1, pp. 1-15, Feb. 2020, doi: 10.1187/cbe.19-04-0082

[5] L. E. Espinosa, "Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence," *Harvard Educational Review,* vol. 81*,* no. 2, pp. 209-240, June 2011, doi: 10.17763/haer.81.2.92315ww157656k3u

[6] L. Goralnik, L. Thorp, and A. Rickborn, "Food system field experience: STEM identity and change agency for undergraduate sustainability learners," *Journal of Experiential Education,* vol. 41, no. 3, pp. 312-328, May 2018, doi: 10.1177/1053825918774810

[7] S. Hurtado, M. K. Eagan, M. C. Tran, C. B. Newman, M. J. Chang, and P. Velasco, "'We do science here': Underrepresented students' interactions with faculty in different college contexts," *Journal of Social Issues,* vol. 67, no. 3, pp. 553-579, Sep. 2011, doi: 10.1111/j.1540-4560.2011.01714.x

[8] H. Huvard, R. M. Talbot, H. Mason, A. N. Thompson, M. Ferrera, and B. Wee, "Science identity and metacognitive development in undergraduate mentor-teachers," *International Journal of STEM Education,* vol. 7, no. 31, pp. 1-17, July 2020, doi: 10.1186/s40594-020-00231-6

[9] L. S. Nadelson, S. P. McGuire, K. A. Davis, A. Farid, K. K. Hardy, Y. Hsu, U. Kaiser, R. Nagarajan, and S. Wang, "Am I a STEM professional? Documenting STEM student professional identity development," *Studies in Higher Education*, vol. 42, no. 4, pp. 701-720, April 2017, doi: 10.1080/03075079.2015.1070819

[10] E. Piatt, D. Merolla, E. Pringle, and R. T. Serpe, "The role of science identity salience in graduate school enrollment for first-generation, low-income, underrepresented students," *Journal of Negro Education,* vol. 88, no. 3, pp. 269-280, June 2019, doi: 10.7709/jnegroeducation.88.3.0269

[11] R. D. Robnett, P. A. Nelson, E. L. Zurbriggen, F. J. Crosby, and M. M. Chemers, "Research mentoring and scientist identity: Insights from undergraduates and their mentors," *International Journal of STEM Education,* vol. 5, no. 41, pp. 1-14. Nov. 2018, doi: 10.1186/s40594-018-0139-y