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Building STEAM for Global Engineering through Collaboration with the Social Sciences and Humanities during the COVID-19 Pandemic

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Building STEAM for Global Engineering through Collaboration with the Social Sciences and Humanities

Introduction

Educators have long recognized the need to integrate social sciences, arts, humanities, and physical sciences to solve such major human problems as environmental degradation, climate change, rural poverty, and global pandemics.[1] Many colleges and universities with engineering programs, for example, have established courses that introduce technical students to the social sciences and humanities for building skills that range from language to problem-solving and creative thinking. [2] The significance of global challenges, while always present, became even more pronounced in the wake of the COVID-19 pandemic in 2020, which shut down entire societies, halted travel, and isolated academic communities. This crisis led many campuses to confront the relationship between global conditions and scientific thought directly. It challenged engineering faculty to incorporate an interdisciplinary pedagogy that supersedes a rigorous engineering curriculum that already left little room for more than the most cursory examinations of the relationship of global trends, societal interactions, economic drivers, and indigenous identities to the design process.

Such pedagogies hold the objective not only of improving engineering education but of encouraging students of the sciences to recognize that technical thought is situated within a human framework, demanding empathy, creativity, persuasion and political support to create solutions that exceed textbook calculations [3]. Furthermore, before students may be taught to think holistically about the interdependency of physical sciences and the social sciences, arts, and humanities, faculty must build their appreciation for crossing discipline boundaries to interact [4]. In engineering education, interdisciplinary learning is encouraged by the Accreditation Board for Engineering and Technology (ABET). Still, the reality of curricula for most institutions is that the social sciences, arts and humanities remain a separate-but-equal educational process, and their relevance to engineering practice and decision-making often is minimized in the classroom. Overcoming this division requires a discipline-agnostic, holistic approach in which science, technology, engineering, and math (STEM) professionals gain exposure to other disciplines to explore and appreciate the importance of synchronizing their efforts with those of the humanists [5].

In the spring of 2020, soon after the pandemic shut down campuses across the world, the Global STEAM Working Group began meeting via a virtual platform to consider options for establishing a broad multidisciplinary forum in which scholars may test the value of previously unexplored interrelationships. The Working Group initiative intentionally chose to use the term STEAM (equivalent to STEM with the addition of the Arts) to commit to a bold, inclusive, and intentional approach that would not leave any ambiguity of purpose in promoting discussion among the sciences and the humanities. A steering group of engineering, history, medicine, social work, chemistry, and global studies faculty plus one undergraduate student representative at the University of Illinois Urbana-Champaign began to hold weekly conversations about global

topics with the intent of building an active forum that could serve scholars, students, and practitioners to better situate science and technology in a societal context. The group was founded under the sponsorship of the Illinois Global Institute and the Illinois Applied Research Institute with a deliberateness that it would not be associated specifically with either science or the arts but as a clear collaboration of both. Out of the conversations, the Global STEAM Working Group launched its first campus-wide forum in September with a three-event series entitled *Global STEAM in An Age of Crisis*. Drawing from small-group explorations of how COVID-19 combined with political upheaval and environmental shifts to produce an age of uncertainty, the group created three roundtable events. The virtual forum (dictated because of COVID impacts on face-to-face programming) featured scholars from around the world exploring the topics of "The Uneasy Relationship Between Science and Politics," "The Conflict Between Science and Compassion," and "Science and the Global in a Brave New World."

In its short active life thus far, the Global STEAM group already has generated considerable interest among both faculty and students across the diverse campus and opened opportunities for engineering students to conduct research and attend courses taught by non-engineering faculty who recognize the intersectional value of situating technical thought in a global context. The working group has established permanent programming to unite the social and physical sciences and humanities in a way that produces globally minded experts who are equipped to function effectively and sensitively in a rapidly changing and diverse international environment. Continued evidence of impact will consist of increased faculty participation, creation of interdisciplinary courses, introduction of a student-facing Global STEAM blog, and facilitation of well-attended events that engage both the physical sciences and the social sciences/humanities.

Program Design

The mission of the Global STEAM working group is "to encourage faculty, students and professionals to explore the intersection between the sciences, medicine and engineering with global and regional questions through dialogue with the social sciences, humanities, and the arts to formulate new approaches to the global challenges of the 21st century." This mission allowed the group to set two specific forum goals that aligned with the need for more and better interdisciplinary discussions:

- Create awareness of the concept of Global STEAM within the university community
- Convey a sense of urgency associated with the pandemic, as well as other important and tragic social events taking place at the time

After extensive discussion, the group agreed that bringing people together through roundtables would be an effective method for spreading the Global STEAM message to faculty across the university and an optimal structure to highlight the open-ended nature of the conversation that such diversity of thought may produce. Through online postings, newsletters, and faculty communications, the forum was introduced, and individual invitations also were sent to faculty who had expressed interest in interdisciplinary dialogue to group members or the sponsoring institutes. Due to the COVID-19 pandemic, all meetings were held virtually, using Zoom® as the

communication platform. Inspired by the early, exploratory conversations of the Working group, the Forum showcased the perspectives of scholars in STEM fields and the humanities by assessing the relationship of science with politics, compassion and global structures, and technology in an unpredictable and shifting global society, with an emphasis on the influences of geographic location and context.

The group programmed three events, each featuring panelists of diverse backgrounds professionally, geographically and culturally. Each roundtable was facilitated by a member of the Global STEAM group.

The first roundtable was scheduled for October 1, 2020. The panelists were a Chemistry Professor at the Federal University of Itajuba, Brazil, a Professor of Atmospheric Science and a Professor of History of Science, both at the University of Illinois. The topic for the first roundtable was the "Uneasy Relationship Between Politics and Science".

The second roundtable featured an Associate Professor of Sociology and an Assistant Professor in the College of Education, both from the University of Illinois, and a Senior Clinical Lecturer at the University of Birmingham, UK, discussing whether there exists a "Conflict between Science and Compassion". The roundtable took place on October 29.

The third roundtable took place on December 3 and explored "Science and the Global in a Brave New World," focusing on political unrest, racial discrimination, pandemic resurgence, and other disruptive global events that are expected to reshape relationships among people across the planet. The panelists were a Professor of Entomology at the University of Illinois, a Professor of Agricultural Engineering at Makerere University in Uganda, and a Professor of Social Work at National Yang-Ming University, Taiwan.

The series concluded with an informal session that allowed participants to reflect on previous conversations with the group of panelists (see below). Total engagement among the roundtables was 79 non-panel participants, and the ratio of faculty to students was roughly 50 percent of each. Additional faculty and students could view the forum sessions afterward by linking to videos of each roundtable off the Working Group's website.

The Working Group honed the topics of the forum by developing a set of three questions for panelist discussion that would be posed in each roundtable. The goal was to stimulate discussion and debate among panelists and encourage the audience to ask questions concurrently in the chat. The facilitator asked the framing questions, and each panelist was allowed to review the questions in advance and prepare their responses. Table 1 illustrates the series of roundtables in terms of the questions asked of the panelists and questions generated by the audience.

As the Working Group had hoped, panelists and audience engaged in extensive interplay to challenge each other's assertions and shape new perspectives on the relevance of their fields to Global STEAM issues.

A brief sample of panelist insights from the third roundtable is shared here:

Facilitator: *What do you understand will be the relationships among science, politics, and the global in this rapidly developing new reality?*

Entomology Panelist: *What is the relationship? Of course, it is rapidly changing, and as a scientist, it can be very frustrating, and I go through highs and lows. Every day, I view it differently. I agree that there is this problem with too much information right now and that people are not as good at critical thinking as they should be if you want to have a functioning democracy. But then I think about in the past, in the 1960s when we were able to go to the moon, people we not as well educated then as we are now, overall as a population. And so I struggle with where the problem lies. It is very concerning for scientists, and I think for the Entomological Society of America. We have found that we need to be more proactive as scientists to ensure that we are getting the funding to do the research that we want to do and we should be doing and that we also need to be able to make sure that whatever our findings are, that they are applied appropriately and understood. I think it is probably more important that we learn how to communicate our science, how to advocate for our science, and that is something that is completely new.*

Facilitator: *How would you define the challenges of this evolving world order and do you assume that science and technology will provide the solutions?*

Social Work Panelist: ...*Will science and technology help us solve these challenges, and the answer is no. What's going to solve the challenges is going to be our ability to work together, to use the information that science and technology and the tools that those provide us to discern what the problems are, what the challenges are, to understand the limits on our knowledge, to ask better questions, and muddle through to find solutions. Both of the other speakers really touched on a critical issue, which essentially boils down to us versus them. Unfortunately, we've come to a place in human history where the kind of technology we have available to us, particularly with social media, allows us to develop a very hyper-specific sense of what our identity and our in-group is, and we create this very specific kind of bubble, which we define by a set of beliefs or ideas or world view that we feel most comfortable in.*

Facilitator: *What do you consider the key ingredients for thriving in this reality as global citizens who live locally, and how might we educate future generations to prepare?*

Agricultural Engineering Panelist: ...*That talks to me personally. I am an African who had the honor to study outside my home country. When I'm on a plane or in a workshop or somewhere and I meet an American, I have something to talk about with them. Why? Because I lived in the US for some years, I know what topics to talk about. I compare myself with my colleagues who have never left Uganda, even when we have international meetings, they struggle to make friends, they struggle to engage because they were locally trained, and I think that could be true for any other student or any other person who even if you are born in the US. I have met students here who have come here for summer programs, who have gotten their passports just because they were coming for the summer program. They experience afterwards is just unbelievable. It's like someone has opened up a new world for them. So for me, the first thing everybody needs to do, and I plan to do it even for my children, is to internationalize their education.*

Table 1: Summary of the topics and questions discussed in each round table.

Questions asked of the Panelists	*Sample of questions generated/discussed*
Roundtable One – The Uneasy Relationship Between Politics and Science	
• Is there an uneasy relationship between science and politics? Why? • Is the relationship between science and politics the same globally? Has the relationship between science and politics been the same through history? • Do politics define science, or does science define politics? a. Does this vary depending upon people and place? b. Should it?	• When was the last time in history that we saw this uneasy relationship? • Did the relationship become stronger over the years? What helped? and who were some key players in making it happen? • Can you speak to the role of trust in the intersection of science and politics? • What can we do (as scientists and citizens) to make science better understood by the public?
Roundtable Two – The Conflict Between Science and Compassion	
• How do we define compassion? Is there a conflict between science and compassion? • How science can help people to become more compassionate? Or does compassion help science to become more affordable/profitable? • Is the conflict between science and compassion the same around the world? What about science and religion? Is compassion inspired by religion?	• Is compassion a foundation in personal ethics, or is ethics a rationale underlying how compassionate someone is? Can we say that a scientist is morally correct if they are more compassionate? • In this era of pandemic and scientific research to find our way out of COVID, can compassion interfere with medical processes?
Roundtable Three – Global STEAM in a Brave New World	
• What do you understand will be the relationships among science, politics, and the global in this rapidly developing new reality? • How would you define the challenges of this evolving world order and do you assume that science and technology will provide the solutions? • What do you consider the key ingredients for thriving in this reality as global citizens who live locally, and how might we educate future generations to prepare?	• Whether it is recognized everywhere or not, science and politics are very intertwined. From your perspective, do you think this should be the case, or do you think there should be certain boundaries between them that are not to be crossed? • What do you think is the reason for people being willing to use technology that's convenient to them, but not listen to the advice of scientists? Where does that disconnect in respect come from?

These brief excerpts fail to capture the richness of the roundtable conversations, which gravitated toward agreement about the need for interdisciplinary education to improve both the

communication and comprehension of facts and be better prepared to use policy in addressing problems that require a scientific approach. An informal debrief gathering with many panelists and several guests took place on February 4 to officially conclude the series. At the final gathering, panelists were able to cross roundtable boundaries and exchange ideas to provide a final showcase of interdisciplinary discussion.

Outcome/Next Steps

This initiative is believed to be the first example of a comprehensive Global STEAM collaboration, made possible by leveraging the infrastructure of a campus-wide institute that houses diverse area studies centers and thematic programs in combination with an institute that supports innovative engineering research for broad and diverse applications. The Working Group forum focused on bringing faculty-level participants to the table to glimpse how experts may explore synergies and disparities in their perspectives on important social issues. By promoting and presenting a non-judgmental and open dialogue untethered to either the STEM fields or the humanities, it was hoped that the forum might break down disciplinary barriers to collaboration among hard scientists and humanists and demonstrate that such dialogues could ultimately produce sound global solutions to both social and physical problems.

In the wake of the forum series, the Global STEAM Working Group was opened to faculty members who had expressed an interest in becoming more involved. Of the initial round of 36 invited faculty members, 22 enthusiastically joined the Working Group. Those faculty come from multiple engineering disciplines and programs as diverse as music, political science, medicine, physics, sociology, engineering, classics, and information sciences. At the same time, the Working Group's student representative began to recruit volunteers to create a Global STEAM blog on the Working Group's website and rapidly assembled a half dozen undergraduate and graduate students from across the campus to act as advisors and curators to a running blog feature.

A third initiative emerging from the roundtable was the establishment of a graduate seminar series for the fall 2021 semester, which will be offered under liberal arts, engineering, and agricultural/consumer sciences rubrics to bring together graduate students around weekly topics of interest to the Working Group faculty members. Working through the Illinois Global Institute, a home department was identified to coordinate concurrent sections of the seminar in each of three colleges of the university, and Working Group members obtained course approvals to create concurrently meeting sections of the seminar. Using this process, no one college or school is the seminar host, eliminating a sense of primacy among student registrants. Working Group faculty will take turns lining up topics and presenters in a mini-roundtable fashion for the seminar each week, and students will be invited to participate directly in discussions as attendees. Organizers of the seminar will focus weekly discussions to illustrate for students how different disciplines are likely to approach the analysis and solution for a given global problem, as well as how practitioners in each field are likely to perform their professional work, from the topography of their professional formation in institutions of higher learning through the day-to-day work in their chosen field. By building an understanding of how different disciplines draw

upon different methodologies and analytical tools, it is hoped that students will understand that the processes of formation and work ultimately institutionalize disciplinary differences and make cross-disciplinary understanding and cooperation all that much more complex.

At least one engineering department has assented to allow graduate students to attend the Global STEAM seminar in place of a semester of a departmental graduate seminar, and another college has requested permission to enroll upper-level honors undergraduates. Additional departments will be invited to offer a similar incentive to their graduate students.

As these initiatives move forward, Working Group members grapple with the typical challenges of technology (Zoom access, blog technology, etc.) and political challenges (distrust among colleges, wariness of commitment demands on faculty). Demonstration of the value of interdisciplinary dialogue through the Global STEAM forum, however, has generated considerable excitement among those faculty and students exposed to the roundtables, and they, in turn, have invited others to join in ongoing efforts. A kick-off meeting of the broader Working Group membership in May produced additional ideas for programming, research, and interdisciplinary scholarship, and monthly meetings are planned for the Working Group beginning with the Fall 2021 semester.

As educators, we look forward to bringing this newfound enthusiasm for interdisciplinary discussion to the classroom. We hope to combine the expertise of members from different disciplines so that students learn to value the need to place themselves in a global context. There are several examples of efforts to provide opportunities for students at the undergraduate level to connect STEM and the global [2]. However, we want to create environments that transcend STEM and put STEAM at the forefront of an integral, necessary education that nurtures the sensibility to learn from local and global partners.

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Appendix

Participant questions submitted via chat feature for each roundtable are shown below.

Roundtable 1 – Science and politics

1-When was the last time in history that we saw this uneasy relationship?

2-Did the relationship become stronger over the years? What helped? and who were some key players in making it happen?

3-It seems like for every example in history of science and scientists being at odds with political authorities, there are examples where scientists aid and further the agendas of those authorities. I'm thinking, for example, of science put into the service of imperial enterprises in the 19th century, or, in a more obvious example, the Tuskegee experiments. Comments?

4-Can you speak to the role of trust in the intersection of science and politics?

5-Although science is considered a "ground truth," we've established that it highly depends on society and local politics. How do you interlay universal truth with local ethics and politics in order to provide and convey scientific information effectively?

6-What can we do (as scientists and citizens) to make science better understood by the public?

7-Most of you phrase the question in terms of how much politicians are listening to scientists. What are the abilities needed for scientists to speak in the public sphere in order to be heard in different global versions of the public sphere? Gallileo certainly had skills of speaking and writing in the political sphere of his time, whatever his ultimate success.

8-Should science drive politics or vice versa? Is there an ideal?

9-How would you recommend practically navigating this issue? What matters more in our current context: minimizing political dissonance or quickly implementing crucial science-backed policy?

10-What role do you believe that increased science communication could play in navigating this uneasy relationship?

11-What are the prospects for meaningful action on climate change from theUS govt? Should we be encouraged that congresspeople understand, or discouraged that they still do nothing?

12-How can we incentivize scientists to become more involved in science policy? If you are a young scientist, it is not tempting to get involved, yet as a citizen, it is important to speak up and to communicate your science.

13-Is the public regard for the "hard" sciences generally better than regard for the social sciences?

14-What role does politics play in the development and direction of science and what role should it play?

15-This isn't a question, but a very interesting commentary on science education is https://www.nybooks.com/articles/2020/07/02/just-use-your-thinking-pump

Roundtable 2 – Science and compassion

1-Do universities have an obligation to teach the link between science and compassion in their degree program? My major used to have an ethics course before I was an undergrad here in engineering, but was removed after too many complaints about its impracticality

2-Is compassion a foundation in personal ethics, or is ethics a rationale underlying how compassionate someone is? Can we say that a scientist is morally correct if they are more compassionate?

3-Do you think compassion is something that can be learned or grown? Besides self-reflection, how can students of science or the health professions integrate compassion more intentionally into our curriculum, whether formally or personally?

4-In this era of pandemic and scientific research to find our way out of COVID, can compassion interfere with medical processes?

5-All of you easily went to individual interactions. What about at the level of public health rather than individual doctors or qualitative researchers? Surely quarantines and vaccine trials force us to subordinate compassion to individuals for vaguer notions of general good or even pure knowledge of a subject or a problem. Isn't there a real dilemma to be faced there?

6-How, if at all, do these questions pertain outside of the social sciences, especially "pure" (non-applied) physical sciences?

7-How does compassion and empathy for people in various situations influence the spread or conveyance of scientific information? Since scientific knowledge is greatly affected by local and global influences, do peoples' experiences with compassion change their decision-making when understanding scientific information?

8-Is there a science OF compassion? Can one empirically study and observe compassion, and would it help us to better understand the value of compassion in scientific investigations?

9-In the panelists' experience, can you teach care and compassion?

10-Have the panel read the book 'Compassionomics: The Revolutionary Scientific Evidence That Caring Makes a Difference'by Stephen Trzekiak and Anthony Mazzarelli? If so, do they think that this goes a long way to providing scientific evidence for the benefits of compassion, and if so should we be playing science and compassion off against each other?

Roundtable 3 – Science and a Brave New World

1-Whether it is recognized everywhere or not, science and politics are very intertwined. From your perspective, do you think this should be the case, or do you think there should be certain boundaries between them that are not to be crossed?

2-What do you think is the reason for people being willing to use technology that's convenient to them, but not listen to the advice of scientists? Where does that disconnect in respect come from?

3-Thedemocratization of scientific knowledge and technology seems to move at a slower speed than its advances, e.g., the gap between people scientifically informed and those who are not is growing; affecting economies, politics, social development globally, etc. Do you envision any way to reduce that gap?

4-How do we balance our desire to preserve the status quo with the need to take actions that may dramatically change our lives and our world? In other words, how can we overcome the barriers to obtain these key ingredients for thriving?

5-In our current climate, where as discussed, we have a significant portion of people who are unwilling to take a COVID vaccine due to scientific distrust and time is of the essence, is the best option for leaders to focus their efforts on re-marketing the science to be more "palatable"? Or should the focus stay on promoting education of the facts? Is there another alternative avenue that you would recommend? Thank you for this very insightful conversation!