Special Session: Smartness as a Fundamental Component of Engineering Classrooms and Culture: Translating Research to Practice

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***Abstract*—The notion of being smart is a concept that underpins the culture of engineering classrooms. That said, it is a topic that is not discussed or addressed by educators directly. Through this special session, we aim to give light to the concept of smartness and the problematic and oppressive practices that result from it given the extent literature on the topic including our own research into the domain. With participants, we aim to generate practical approaches to addressing smartness that work in a variety of contexts to broaden participation in engineering via more inclusive classrooms.**

Keywords—smartness, broadening participation, classroom applications

I. Goals

Has anyone ever told you that you have to be smart to be an engineer? This is a common and longstanding narrative about engineering [1], [2]. The goal of this session is to facilitate discussion around the presence of smartness in engineering classrooms and generate collaborative ideas for changing problematic and oppressive practices associated with the notion that to be an engineer, you must be smart. In this session, we will:

- Review extant literature related to smartness being a problematic cultural construct and practice.
- Share empirical findings from our own research into smartness in the context of undergraduate engineering education.
- Provide attendees with the opportunity to reflect on their classroom practices and collaborate on pedagogical strategies for meaningful change.
- Engage attendees in meaningful conversations about ways to facilitate discussions within their own classrooms or educational contexts.

II. Description And Selected Relevant Literature

In this special session, we will present the theoretical underpinnings of smartness as a cultural practice, drawing on literature from sociology, K-12 education, and our own work with undergraduate engineering students. Specifically, we build on the work of Beth Hatt [3]. Hatt's work, which is framed around the cultural and identity research of Holland et al. [4], posits that smartness is a culture practice for which we all play an active role in creating. If we all play an active role in the creation of smartness, this means we can also play a role in changing what smartness means in engineering.

Using this framing, we (as educators, engineers, etc.) collectively construct what it means to be smart in each of our classrooms. Therefore, along with students, we have agency when it comes to defining and enacting what behaviors are valued or recognized as "smart" in our classrooms. That said, we are socialized to believe that how intelligent students are is an inherent, fixed trait [5]. Additionally, intelligence testing has historically demonstrated oppressive practices where those who are deemed smart is often raced, classed, and gendered [6], [7], [8]. Work by researchers such as Dwek [5] has encouraged a shift away from this antiquated view; however, these beliefs are deeply held and difficult to uncover let alone change.

In this special session, we will build on the literature discussed above by sharing some of the results of our research related to smartness [9], [10], [11], [12]. We will also begin a dialog with educators on how we can support students in understanding the impacts of smartness in engineering. We have started to translate our research findings to practice, which we will share through examples; however, in this special session, we will further engage attendees in deep discussions and brainstorming on other ways we can address smartness in our classrooms.

III. Rationale and Novelty

Engineering students are typically those who have been socialized within K-12 education to believe that they are smarter than others [9], [13]. Their beliefs and identities around being "smart" are brought with them into our engineering classrooms, which impacts the way they understand themselves as engineers [9], [14]. These beliefs are crafted well before they enter our classrooms which makes addressing them difficult. Simultaneously, admitting that you believe you are smarter than other people is often taboo. Yet, those of us in engineering are socialized to believe that we are.

The first year of engineering school is a particularly challenging time for many students. While some stay, others leave for a variety of reasons ranging from interactions with faculty, grades, expectations of work, etc. (e.g., [15], [16], [17]). During this time, many students also wonder if they are smart enough to be an engineer. For example, many students are finding that they need different learning strategies to keep up with what is happening in class. At the same time, students with particular social identities (e.g., non-white, non-male) are not recognized for the value they bring to their engineering teams which further contributes to them questioning their place (e.g., [18], [19]). Failure to recognize and disrupt the problematic aspects of smartness such as these not only leads to feelings of student isolation but may lead to students leaving the field.

These complex aspects of smartness as a cultural practice can lead to students who have always excelled in school to feel, for the first time, as if they do not belong [20]. Furthermore, the ways in which we allow these realities to remain implicit and unspoken can isolate students from one another and cause harm. As educators, it is our duty to help students through this time of transition and questioning. We must help them make sense of the new world around them and bring to light these various narratives.

Because this is a topic that is not often discussed explicitly, is something we all contribute to, and is culturally pervasive, we believe FIE attendees will be interested in engaging with dialog about smartness. Attendees of the special session will develop strategies to support their students as they grapple with the concept.

IV. Agenda and Description of What to Expect During the Session

This special session will be 80 minutes long and include a variety of discussion activities. Our goal is to engage attendees and further this work focused on application. Below is our anticipated agenda.

A. Introduction with attendees to understand what they believe makes a smart engineering student (10 minutes).

We all bring different experiences and beliefs with us to the classroom. As such, we will start this session getting to know each attendee to understand their lived experiences related to smartness and how it relates to their engineering students. We will focus on the goal of understanding what makes a smart engineering student through a collaborative brainstorming activity.

Each participant will be asked to supply 5 words or short phrases that describe a smart engineering student to an online platform to create a word cloud. This visual will capture the group's starting view of what makes a smart engineering student. We will revisit this image at the end of the session.

B. Overview of theoretical components of smartness and our related research findings (20 minutes).

As described above, this session is based on a multi-year project where we focused on understanding what smartness means to students in the undergraduate engineering context. Using images developed by our team in collaboration with a professional graphic designer, we will establish a baseline understanding with participants about the concept of smartness grounded in research from Hatt [3]. Our own work furthers past research highlighting the key takeaways related to the impacts of smartness in engineering specifically (e.g., [9], [11], [12]).

C. Smartness in the Eyes of Students Activities with Follow Up Participant Reflection on ways smartness impacts courses (20 minutes).

Participants will be asked to brainstorm the many ways that smartness may manifest in their classrooms considering their grading practices, classroom discussions, pre-requisites, etc. Through a guided worksheet, participants will be asked to consider the following prompts related to one course they teach. We will ask participants to examine their syllabus and course management system as they complete this exercise.

- How does the course design and implementation reflect our views on smartness?
  - What are the learning objectives?
  - What are the grading practices?
  - What are the methods of assessment?
- How do socio-historical-cultural forces impact our teaching context?
  - What is the history of the course and/or program?
  - How does the course reflect the cultural landscape of engineering?
  - What expertise is modelled by the teaching team?
- How are our students' values reflected in our classroom praxis?
  - What do we expect students to produce in the course?
  - How do we uncover and incorporate our students' values and/or motivation(s) for taking the course?
  - What power do our students have in the course?

These prompts will serve to lay the foundation for actively working to disrupt the impacts of smartness in our classrooms.

D. Intervention Brainstorming Activity & Group Share Out (25 minutes).

In small groups or individually, we will ask participants to brainstorm ways to incorporate smartness-based activities into their classrooms. Given the unique context of everyone's teaching, these activities may take a variety of forms, and we hope this activity allows for broad idea generation and sharing. Our goal is to have participants actively consider changes to one educational practice related to smartness from the brainstorming above.

We will start this section by sharing our approach to addressing smartness in a first-year engineering classroom. In this example, we gave students a chance to exercise their agency related to this topic in the context of a team working agreement – the team working agreement has been a standard

assignment in the class for many years and through this modification we connected it to the impacts of smartness related to teamwork. Specifically, we started the activity by asking students to reflect on their own experiences with smartness; what it means to them, how they identify with being smart, and smartness in an engineering context. We then provided them with some background information to introduce them to the idea that smartness is socially constructed and something that we all actively participate in within our educational contexts. We then provided them with findings from our research related to what other students value as ways of being smart in engineering. This then prompted a class discussion focused on whether the students agreed with our findings and how it related to their own beliefs and values. The final portion of the activity was a group discussion within their assigned semester-long project teams about how they want to construct smartness within their project groups; how they will value being smart during their design project. Finally, teams were asked to develop three team specific assessment criteria to add to their team working agreements based on their agreed upon team values.

Special session participants will be given a worksheet to help them think through the educational practice they would like to adjust documenting the current practice, how it relates to smartness, and how they could adjust the practice to be more inclusive. Each group will be asked to share their revised practice along with any new insights they have gleaned about the ways that smartness manifests in our classrooms.

E. Closing and Facilitator Reflection (5 minutes).

We will end the session recapping our discussions to ensure all participants can further share their experience with their home institutions. We will also debrief on ways we can continue to discuss smartness in our classrooms as the first step to disrupting the impacts of smartness is recognizing and bringing light to the practice.

We will close the session by revisiting the word cloud created at the start. We will ask each participant to add 3 more words to the cloud based on the session today and their current understanding of what makes a smart engineering student. This new cloud will include the initial words/phrases along with new insights. This image will be used to showcase the growth in the session while still depicting the deeply held beliefs that are embedded in our culture and society. We will not be able to fully address the impact of smartness as a culture practice in this session; however, we believe participants will leave with a new understanding and perspective on smartness in our engineering classrooms.

V. Expected Outcomes

By the end of the special sessions, attendees will understand smartness as a powerful and harmful social construct in engineering. Additionally, attendees will have started to develop skills for engaging in meaningful reflection and discussion with students on how smartness is constructed within their classrooms. The results of this special session will be used to inform future classroom practices related to smartness in engineering. While our research work has begun to address this topic from a research lens, we believe that true impact for our students needs to happen within classrooms with educators like those who attend FIE.

VI. About the Facilitators

This session will be facilitated by three researchers who have engaged with the topic of smartness as a team for multiple years in their research and with their students. The facilitators have also all taught first-year engineering classes engaging with difficult topics with their students during times of transition (e.g., beginning an engineering program). The facilitators have also run a variety of workshops over the years with a focus on making the sessions engaging and impactful for attendees. Below each researcher has provided a bit more information about their expertise related to this specific session.

Rachel Kajfez is a mixed methods researcher who studies identity to improve the student experience. She is deeply committed to translating research to practice while supporting educators in their development. Through this work she has examined the impacts of smartness in her teaching and personal life, always looking for ways to disrupt our cultural norms to bring about impactful educational change.

Amy Kramer is an instructor and course coordinator in the Fundamentals of Engineering program at The Ohio State University. Through her engagement with students, personal educational experience, and research, she has observed how deeply personal and salient the topic of “smart enough” is for engineering students. Her work in this area as well as her research in engineering epistemology have enabled her to better support students and create interventions to help students broaden their conceptions of what it means to be a smart engineer.

Emily Dringenberg is a qualitative researcher committed to understanding and disrupting smartness as an oppressive cultural practice. As a white woman, parent of white children and tenured engineering professor at an R1 institution, she simultaneously experiences significant privilege and oppression; she continues to grapple with being both a perpetuator and disruptor of the status quo for who is considered smart.

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willingness to be open during the various stages of data collection.

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