You're an Engineer? You Must Be Really Smart! A Theoretical Discussion of the Need to Integrate "Smart" into Engineering Identity Research

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ABSTRACT

Background: Those who participate in engineering are often assumed to be smart by others. At the same time, the cultural construction of what counts as "smart" is biased and therefore functions as a barrier to broadening participation in engineering. While considerable work has been done to understand engineering identity, how students understand themselves as smart is rarely made explicit in engineering identity research.

Purpose: This paper is a theoretical discussion which highlights the need for engineering identity research to integrate students' understanding of themselves as smart. By not incorporating students' understanding of themselves as smart explicitly in work on engineering identity, we allow the bias in what gets recognized as smart to remain implicit and oppressive.

Scope: In this paper, we argue that the idea of smart is very salient in engineering contexts and contributes to inequity. Then, we demonstrate how three different framings of identity allow for the explicit integration of how students are understanding themselves as smart. We also present selected examples from our empirical data to illustrate the concrete ways in which students' understandings of themselves as smart manifest in an engineering context.

Conclusions: We provided explicit opportunities for researchers to integrate students' understandings of themselves as smart across three different framings of identity and how such understanding has shown up in our empirical research. In doing so, we conclude that making "smart" explicit in engineering identity provides a way to understand the exclusionary nature of engineering, and a new lens to apply when considering efforts to broaden participation in engineering.

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1. INTRODUCTION

Those who participate in engineering are often assumed to be smart by others. Frequent public messaging emphasizing the importance of math and science in engineering along with assumptions about the difficulty of engineering perpetuate this narrative (National Academy of Engineering, 2008; Sochacka et al., 2014; Stevens et al., 2007). Both engineering students and engineering faculty believe that engineers have an above average understanding of math and science and are generally high academic achievers (Godfrey & Parker, 2010). Faculty and students also both construct ability-based hierarchies in engineering classrooms in ways that result in shared beliefs about who is cut out for engineering and who is not (i.e., not smart enough); this constructed hierarchy is rooted in even the most mundane classroom interactions, such as sorting students based on prior experiences in coding in an introductory programming class (Secules et al., 2018). Furthermore, our prior work indicates that students tend to associate engineering with being smart by describing an engineer and a smart person in similar ways (e.g., engineers solve complex problems, smart people solve complex problems) (Kramer et al., 2021). The association of engineering with being smart matters for individual students because the assumption that engineering requires exceptional intellectual or academic ability drives many aspects of students' experiences and academic decisions (Anderson-Rowland et al., 2013; Besterfield-Sacre et al., 1997).

At the same time, what counts as "smart" is culturally constructed in biased ways and therefore functions as a barrier to broadening participation in engineering. Scholars have demonstrated that the designation of some individuals as smarter than others in educational institutions is a racist, classist, and otherwise oppressive practice (Leonardo & Broderick, 2011; Oakes, 2005). In the context of education in the United States, students who are identified as a high academic achiever, or as academically gifted are afforded more educational opportunities such as taking advanced or college-level coursework prior to graduating high school. Identifying students as academically gifted is rooted in privilege and often excludes students based on race, socioeconomic status, and gender (Oakes, 2005). Our own work has indicated that the students who end up in engineering at our institution were consistently identified as smart through gifted programs or placement in advance courses within their pre-college educational experience, and these students generally held more privileged identities (i.e., male, White, middle to upper-middle class, etc.) (Kajfez et al., Forthcoming). Given the salience of being "smart" in engineering and the ongoing reality that engineering lacks diversity, equity, and inclusion, explicit attention to how engineering students understand themselves as smart is warranted as a component of broader efforts to broaden participation.

Additionally, scholars have done considerable work to understand how the development of an engineering identity contributes to participation in engineering. The frameworks and findings of some scholars have already revealed that the idea of smart is embedded in engineering identity (for example, Godwin et al., 2016; Huff et al., 2021; Tonso, 2007). Yet, how students understand themselves as smart has not been the explicit focus of engineering identity work. In this paper, we demonstrate how three different framings of identity allow for the explicit integration of how students are making sense of themselves as smart. Additionally, we provide student quotes from our related empirical work to illustrate the concrete ways in which students' understandings of themselves as smart manifest in alignment with the different theories of identity. Without making how students understand themselves as smart explicit in praxis related to engineering identity, it will remain implicit and therefore a mechanism to perpetuate the status quo and prohibit broadening participation in engineering.

1.1 MOTIVATION FOR THIS THEORETICAL CONTRIBUTION

Our motivation to make this theoretical contribution arose from our closely related empirical research. To start the data collection of our project, we conducted interviews with students in their first year of engineering undergraduate education to examine their beliefs and identities related to engineering and smartness. Specifically, we focused on four constructs of interest: beliefs about engineering, identity as engineer, beliefs about smartness, and identity as smart.

We then conducted two follow-up interviews over the course of a year with the same participants to further understand their academic decision making in relation to their identity as smart and as engineers and the nuances around how they understood themselves as smart and as engineers as they transitioned out of first-year engineering programs.

As we engaged in the data analysis, we wanted to understand when and how these constructs of engineering beliefs, identity as engineer, beliefs about smartness, and identity as smart were related to one another. We expected to see some overlap given the literature (and our own experiences) that nods to engineering as something for smart people, particularly in the section of our interview where we explicitly asked participants to make connections between the four constructs. However, what emerged to us during our analysis process was a much stronger connection between students' identities as engineers and their identities as smart throughout the interviews than we initially expected. Specifically, participants seemed to be making sense of themselves as engineers and as smart simultaneously and with very little distinction between the two. As we began to recognize how deeply intertwined identity as engineer and identity as smart were for the participants, we began pushing ourselves to rethink how existing theories of identity might allow for the incorporation of how students are making sense of themselves as smart in the context of undergraduate engineering education.

2. BACKGROUND

In this section, we first detail our operationalization of "smart" and then provide a brief overview of identity as a research construct as well as the need to further develop our understanding of engineering identity. Finally, we present three theories of identity chosen to illustrate how a range of framings of identity can and should allow for the integration of how students understand themselves as smart in the context of engineering.

2.1 THE CULTURAL CONSTRUCTION OF WHAT COUNTS AS SMART RESULTS IN OPPRESSION

To make the focus on "smart" explicit, the term needs to be operationalized. The major argument we wish to make here is that what counts as smart behavior or characteristics is culturally constructed and that the norms and beliefs embedded in that cultural construction are oppressive. To start, it is important to understand that the normative assumptions about what counts as smart behavior are culturally constructed (Sternberg, 2004, 2007). For example, Western constructions of intelligence assume a person's intelligence is fixed, innate, and independent of their commitment to work hard or educational experiences (Dweck, 2006; Dweck, 2000; Oakes, 2005). Alternatively, individuals from India are more likely to believe that everyone has the potential to become highly intelligent compared to United States citizens (Rattan et al., 2012).

Such cultural differences are oppressive when the dominant group enforces their norms and beliefs for what constitutes "smart." In the context of engineering education (and Western society more broadly), the construction of ability reflects White, middle or upper-middle class, and masculine values (Hatt, 2012; Okagaki & Sternberg, 1993; Sternberg, 2002). As a result, who is recognized as smart in schools in the United States is raced, classed, and gendered. Research consistently shows that children from families who are working-class, non-White, of an ethnic/racial-minority, or have just a single parent are less likely to be deemed "smart enough" as they are disproportionally placed into the lowest educational tracks (Curtis et al., 1992; Oakes, 2005). More specifically, children from parents who are unskilled workers were 20 times more likely to be placed in a slow learner class than children of professionals (e.g., accountants, engineers, and lawyers) (Curtis et al., 1992). White, middle-class, and male students are labeled as gifted at significantly higher rates than other students (Curtis et al., 1992). For example, Hatt's (2012) ethnographic study of an elementary school classroom revealed how teachers' biased perceptions of students resulted in Black boys from low-income households receiving less recognition than others who behaved in similar ways, which shaped students' shared beliefs that the Black boys were not as smart as the other children.

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The inequity that results from the fact that what counts as "smart" is culturally constructed indeed shows up in how students understand themselves in the context of engineering. For example, female students in engineering programs have lower levels of self-efficacy and self-confidence than their male peers, even when their academic performance is the same or better than the men (Geisinger et al., 2013). In fact, researchers have shown that the degree to which a field is believed to require innate intelligence is negatively correlated with participation of women and African Americans (Leslie et al., 2015).

2.2 ENGINEERING IDENTITY IS COMPLEX, IMPORTANT, AND REQUIRES CONTINUED DEVELOPMENT

Identity is a complex construct which has been defined across educational research in many ways. While some research focuses on identity with respect to social demographic groups such as sex, race, ethnicity, class, age, and so on, most scholars argue that there is a personal belief and additional social and cultural aspects to a person's identity (Vignoles et al., 2011). In educational research, aspects of identity that go beyond an individual's identification with a particular demographic category include how students characterize and label themselves and each other within academic settings (e.g., the honors student vs. the class clown). Thus, identity has become an analytic tool for investigating and understanding learning in sociocultural contexts (Sfard & Prusak, 2005).

Within engineering education, identity research has become more prominent in recent years (Morelock, 2017; Patrick & Borrego, 2016; Rodriguez et al., 2018). Researchers have investigated the relationship between identity development and retention, academic outcomes, and the impact of interventions in higher education settings (Morelock, 2017; Patrick & Borrego, 2016). For example, researchers have shown that engineering identity can be a predictor of engineering career choice (Godwin et al., 2016) and persistence in engineering majors (Patrick et al., 2018; Pierrakos et al., 2009). Researchers have drawn on a wide variety of theories including multiple identity theory, critical theories, and sociocultural or socialization theories to operationalize engineering identity (Patrick & Borrego, 2016; Rodriguez et al., 2018).

Given the growing body of research on engineering identity and wide variety of definitions, researchers have called for the need to generally refocus and rethink identity in engineering, which they argue is needed for a richer understanding of the construct in engineering (Patrick & Borrego, 2016). We offer a theoretical contribution to this call by arguing that given the connection between being smart and engineering, how students understand themselves as smart forms an ever-present factor in the construction of their identities as engineers.

2.3 FRAMINGS OF IDENTITY DISCUSSED IN THIS PAPER

In the following sections, we discuss three theories of identity used in engineering identity research to demonstrate how a range of framings of identity allow for the integration of how students are making sense of themselves as smart: Burke's (2003) framing of identity, Gee's (2000) framing of identity, and Holland et al.'s (1998) framing of identity and agency in cultural worlds. To be clear, engineering identity has been theorized in engineering education literature in many ways (Morelock, 2017; Patrick & Borrego, 2016; Rodriguez et al., 2018). We acknowledge that other theories of identity have been used in engineering education research and provide valuable insights. We chose to scope the paper around the three selected framings of identity because they offer different views of how the construct of identity is defined and positioned relative to the individual and their sociocultural context. Burke's (2003) framing of identity focuses on how the influence of a person's roles in life, their unique personal traits, and the social groups to which they belong to define the self. Whereas Gee's (2000) framing of identity places emphasis on how the individual negotiates their identity within sociocultural contexts, specifically how individuals are recognized by others as certain types of people. Finally, Holland et al.'s (1998) framing of identity takes a holistic approach theorizing identity construction of an agentic self through participation in a sociocultural context. Each of these theories will be expanded upon in the following sections as well as how each framing of identity can allow for the integration of how students are making sense of themselves as smart. We also provide selected examples from our related empirical data to illustrate the concrete ways in which students' understandings of themselves as smart manifest. Based on our work, we argue that students' understanding of themselves as smart should be integrated regardless of the theory of identity used in efforts related to engineering identity.

3. BURKE'S (2003) FRAMING OF IDENTITY

Burke (2003) summarizes and synthesizes three categories to describe the identities a person can have: personal identities, social identities, and role identities. Personal identities relate to someone's personality traits, such as being charismatic. Social identities relate to the groups to which a person belongs, such as being an American or a college graduate. Role identities relate to the roles a person fills, such as being a professional engineer, which includes the responsibilities and experiences that are indicative of that role.

Applications of this identity approach in engineering education research often consider engineering identity as a role identity (e.g., Godwin et al., 2016); however, engineering identity scholars have also considered identity using multiple components of Burke's (2003) synthesis. For example, Ross et al. (2021) used social identities of race and gender alongside role identity as engineers in their study of engagement of Black women in engineering professions. Specifically, they used Burke and Stets' (2022) structure–agency dialectic approach. Ross et al.'s (2021) study particularly highlights how important the educational experiences of Black women engineers are in relation to their engineering identity negotiation, and particularly noted that participants' identities as engineers were comprised of both role identities related to their occupation as engineers and social identities related to their race and gender.

Godwin (2016) drew on the notion of personal, social, and role identities and more specifically the work of Hazari et al. (2010) in physics who drew on Carlone and Johnson's (2007) research on women of color in science to operationalize engineering identity specifically as a subject-based role identity. Godwin (2016) framed engineering identity as consisting of interest, performance/competence beliefs, and recognition. As such, to negotiate one's engineering identity, a person must 1) demonstrate an interest in the subject matter and content of engineering, 2) be able to perform and demonstrate competence within the academic subjects related to engineering, and 3) be recognized by themselves and others as someone who can do engineering. Extending Godwin's (2016) work in engineering identity research, Patrick et al. (2018) demonstrated using engineering identity scale items that indeed there are connections between the three components (i.e., students' interest, performance, and recognition in engineering-related subject matter) and students' identification with and persistence in engineering.

3.1 SMART AND BURKE'S FRAMING OF IDENTITY

When considering the theoretical connections between Burke's (2003) synthesis of identity and the ways in which people understand themselves as smart, we see connections between each identity type. First, when considering personal identity, which is a trait that someone holds, we see alignment between personal identity and how individuals believe their intelligence to be an inherent trait (e.g., I believe that I am innately smart). Indeed, the belief that being smart is an individual trait aligns with Western constructions of intelligence that assume a person's intelligence is fixed and innate (Dweck, 2006; Dweck, 2000). Similarly, in our prior work related to students' beliefs about smartness, we found that undergraduate engineering students tend to believe that being smart in engineering is an individual capacity (i.e., an individual trait) to work efficiently (Dringenberg et al., 2022). It is important to note that such beliefs can be problematic because they ignore the reality that what counts as smart is socially constructed in biased ways and perpetuates inequity (Dringenberg et al., 2022).

Second, when considering Burke's (2003) framing of social identity, we see alignment with how individuals understand themselves as smart based on social and cultural expectations of what it means to be smart and the ways in which the social groups they belong to are positioned as smarter than others (e.g., engineers). As Hatt (2012) argues in her work on the cultural practice of smartness within educational systems, students learn what counts as smart and come to see themself as smart (or not) through co-constructed beliefs about what is recognized as smart in a given sociocultural context which results in relative social positioning (e.g., an understanding of which students are smarter than others). Additionally, for students who are recognized within their social context (e.g., schools) as smart in certain subjects, such as mathematics and science, belonging to the group of "smart mathematics students" or "smart science students" could set them on a path to majors and careers related to engineering since being "smart" in math and science aligns with the socially constructed narratives of the discipline (National Academy of Engineering, 2008; Sochacka et al., 2014; Stevens et al., 2007).

Finally, when considering Burke's (2003) framing of a role identity and more specifically the further operationalization of a role identity as engineering identity by Godwin (2016) which consists of performance/competence beliefs, interest, and recognition, there are additional theoretical connections to how students understand themselves as smart. When considering competence beliefs and interest there is a connection because we often consider ourselves smart in a subject when we have a greater interest in it and perceive ourselves to be proficient in it. Related to recognition, we have found in our own work that recognition as smart during students' pre-college experiences (such as being placed in gifted or honors programs) contributes to students' understanding of themselves as smart enough for engineering (Kajfez et al., Forthcoming) (note that this also overlaps with social identity considerations). Furthermore, being recognized (or positioned) as smart is a key component of how smartness is culturally practiced in schools (Hatt, 2012), This aspect is significant because who gets recognized as smart (or not) is informed by social and cultural forces and is shaped by factors such as race, gender, and socioeconomic status (Hatt, 2012; Leonardo & Broderick, 2011).

3.2 EXAMPLES FROM OUR EMPIRICAL WORK

We present excerpts (not findings) from our empirical research (interview data with undergraduate engineering students at a large research university in the Midwest) to provide illustrative examples of how students understood themselves as smart within the context of undergraduate engineering considering Burke's (2003) framing of identity. Evidence from our research study showed a connection between how participants understood themselves as smart and each of the identities noted by Burke (2003).

First, when considering personal identity as framed by Burke (2003), our empirical work provided examples of how students understood themselves as smart through the belief that their smartness is an inherent trait. For example, Sarah, a first-year engineering student in the honors programs said, "I have a natural brain that tends me towards math and physics and understanding" when discussing how she views herself as smart in engineering. From the quote, it is clear that Sarah believes herself to have an inherent capacity for math and physics and that is, in part, how she understands herself as smart. Students also discussed their ability to understand concepts quickly as an inherent trait that makes them smart. For example, James, a first-year engineering student said:

> So I think that's where my idea of me being smarter than other students came from, when I was younger, that I was able to learn math quicker. And I am able to learn engineering and design quicker than my peers.

Indeed, many students described their understanding of smart as an individual ability or trait to pick up on things more quickly than others.

When considering social identity as framed by Burke (2003), we noticed how students seemed to understand themselves as smart through participation in social groups that are associated with engineering. One participant, J, suggested how his participation in the honors engineering program (and double majoring) as well as his participation in an engineering research lab had become a big part of his identity. When describing how he understands himself to be smart, he states:

> The whole double-majoring thing. Being involved with research at an engineering facility and being in honors and trying to do all of it. I guess it's just kind of a big part of who I am.

In the case of J, his participation in an engineering research group and the honors program are the social experiences through which he is recognized as smart and how he understands himself as smart.

Finally, by considering Godwin's (2016) further operationalization of engineering identity as a role identity (Burke, 2003), we noticed how participants indicated that performance or interest in math and science was a way that they understood if they or others are smart enough for engineering. For example, Skylar, a young woman in the undergraduate engineering program, stated, "Being smart in engineering means that to me that you have this grasp on science and math and problem solving." Additionally, J mentioned that when he thinks of an engineering student, he sees the "traditional image of a good student or STEM student, where they've always gotten good grades in school…I mean to get [into engineering school], you do have to go through a very difficult curriculum." Performing well or being a "good" student and a "STEM" student is essentially the same thing, according to his statement. Thus, performing well in school (i.e., getting good grades), being interested in subjects related to engineering like math and science (which are the subjects that "smart students" are interested in), and being recognized as smart in those subject areas by others is all connected to how students understood themselves as smart and identified themselves as engineers in the context of engineering education.

4. GEE'S (2000) FRAMING OF IDENTITY

To further discuss how smart can and should be integrated in any theory of identity, we explore the framing of identity by Gee (2000). Gee (2000) theorized identity as "being recognized as a certain kind of person in a given context" (p. 99), and this recognition as a certain kind of person is negotiated within different contexts. Gee further explains that there are four views of identity: nature-identity, institution-identity, discourse-identity, and affinity-identity. These four views of identity coexist within society; however, in certain contexts one identity view may be foregrounded. These views of identity can be applied separately or together as a lens for researching identity. Nature-identities are attributed to a force of nature or a state of being in which a person has no control, such as being born a twin. Institution-identities are attributed to the authority of an institution, such as being an honors student. Discourse-identities are attributed based on dialogue with other individuals, such as being described as a hard worker. Affinity-identities reflect a shared practice within a group of people based on their interests, such as being a robotics hobbyist.

Additionally, Gee (2000) explains that in many cases all four views of identity can be applied to a single example, for the purposes of this paper let us use the example of being identified as academically gifted. In this case, the view of nature-identity would be that a person is born gifted, and this was not within their control. Being identified as gifted would become part of someone's institution-identity when they are placed into the gifted track within the institution of K–12 education. In the case of being identified as gifted, this can become a discourse-identity within the context of school through the dialogue used by students and others that describe gifted students as being smart, a genius, academically talented, and the like. Finally, being identified as gifted could be viewed as an affinity-identity, as people within this group gather and form mutual interest groups or engage extracurricular activities related to their identity as academically gifted.

Applications of Gee's (2000) theory in engineering identity research often apply the view of institution-identity (e.g., Capobianco et al., 2012) or discourse-identity (e.g., Eliot & Turns, 2011), although others apply multiple views of identity as a lens (e.g., Paretti & McNair, 2012; Weiner et al., 2018). For example, Capobianco et al. (2012) used institution-identity as part of their multiple identity model for examining engineering identity in preadolescent girls. Eliot and Turns (2011) applied discourse-identity in their framework for engineering professional identity development, using narrative analysis within their study of undergraduate engineering students. Paretti and McNair (2012) applied institution-identity and discourse-identity to their engineering identity framework and examined how institution and discourse identities intersect in engineering for both students and professionals. In examining the identities of students in Makerspaces, Weiner et al. (2018) used all four views of identity and developed two additional views of identity, material discourse-identity, which is related to the use of materials and tools, and relational-identity, which is related to family and social influences.

4.1 SMART AND GEE'S FRAMING OF IDENTITY

When considering Gee's (2000) framing of identity, each of the four views of identity can relate to ways that people understand themselves and others as smart. First, one view of understanding "smart," particularly in Western constructions of intelligence, is that people are born "smart," or born with a certain level of intelligence (Dweck, 2006; Dweck, 2000), this relates to a nature-identity view (Gee, 2000). It is worth noting that people do have cognitive and neurological differences that are explained by nature and due to forces outside of their control. However, certain cognitive and neurological differences within various historical, social, and cultural contexts have been rewarded in ways and become synonymous with being smart. For example, in Western culture academic ability is constructed in a way that reflects White, middle or upper-middle class, and masculine values (Hatt, 2012; Okagaki & Sternberg, 1993; Sternberg, 2002).

Second, using Gee's (2000) view of discourse-identity, the individual discourses of being smart are how students negotiate their identity as smart. These discourses happen at a local and context-specific level, where individual dialogue indicates that certain people or groups of people are "smart." Understanding "smart" with a view of discourse-identity aligns with how smartness is theorized as a cultural practice by Hatt (2012) who argues that one of the central ways that smartness is culturally practiced in schools is through discourse. These discourses continue to perpetuate the status quo of inequity related to who is recognized as smart and who is not, as they are informed by the social and cultural context and values which constructs "smart" in racial, gendered, and classed ways (Hatt, 2012; Leonardo & Broderick, 2011).

Third, in taking an institution-identity view (Gee, 2000), an example would be a student that is identified as gifted and tracked as such within the formal institution of their school. Any form of institutionalized tracking or sorting of students based on the performance on certain aptitude or proficiency tests would be categorized as institution-identities. Ability-based tracking is at the very core of how smartness is practiced in schools (Hatt, 2012). This sorting of students explicitly contributes to classed, racial, and gender inequities in education (Curtis et al., 1992; Oakes, 2005).

Fourth, "smart" can be viewed as an affinity-identity (Gee, 2000). This primarily relates to the groups that students choose to participate in within the context of school and related extracurricular activities. For example, a student may experience an affinity-identity related to being identified as smart if they participate in academic clubs or competitions, such as Science Olympiad, FIRST Robotics, Academic Decathlon, mathematics club, or other activities of the sort. With affinity-identity there is also overlap with the choices students make related to the courses that students enroll in. For example, if a student has an interest in mathematics or science, they are more likely to enroll in higher levels of coursework related to those subject areas (which could be considered affinity groups), setting them on a path toward certain careers like engineering (Godwin et al., 2016).

4.2 EXAMPLES FROM OUR EMPIRICAL WORK

From our research study, we noticed there is a nature-identity view (Gee, 2000) of being smart that was shared among several participants. In most cases this view was shared when describing that it means to be smart. For example, in his first year of engineering Hannibal said, "You can be born with this innate smartness like a piano prodigy or someone who's just really good at math." A few participants were even more explicit, mentioning nature and being smart. As Jackie, another first-year engineering student, states,

> I always think being smart is a natural ability, like something that comes easily to you. Just being able to understand something easily or quickly. It's kind of like something you're born with if that makes any sense.

When using Gee's (2000) views of identity to understand how engineering students negotiate their identity, the nature-identity view is how some engineering students understand themselves or others as smart.

We also noticed that participants' statements revealed dialogues or discourses that they had participated in stating that engineers are smart, which provides examples of a discourse-identity view (Gee, 2000). Anna, a young woman who changed majors from business to engineering in her second year, stated:

> I was in business and [engineering students] would sort of make fun of business students. Business students laugh about it, and other engineering students laugh about it, and it's all in good fun, but it would sort of annoy me because just because we're business majors it doesn't mean we're stupid.

Daniel, a young man also in his first year of the engineering program, referenced the same comparison: "Everyone tried to pick on some business majors for picking the easiest major and whatnot. So, I feel like there's definitely some stereotypes around engineering majors. Like, we think we're smarter than everybody else." Additionally, Chris, another young man in his first year, said, "A lot of people are like, oh wow, you're an engineer, you must be so smart." Looking at these quotes, we see within the discourses described by our participants, undergraduate engineering students are simultaneously recognized as smart and as engineers. Furthermore, engineering students are recognized through discourse as being smarter than others.

Many participants indicated that being tracked into gifted or honors classes, or in other words, given the institution-identity (Gee, 2000) of gifted or honors student was how they identified as smart in the context of educational settings. For example, when we asked Anna to tell us what she was like as a high school student, she simply replied, "I was in the honors and advanced classes." Thus, she understood her identity as smart in high school through the institution-identity of honors student. As previously mentioned, tracking students is an oppressive practice (Curtis et al., 1992; Oakes, 2005). Moreover, students' academic choices around taking advanced courses or enrolling in specialized schools is related at least in part to this institutional tracking. Allen, a young man in his first year, displays an institution-identity related to being smart and an engineer that comes from being tracked in a gifted program in elementary and middle school, then choosing to attend a STEM high school as well as taking advanced courses: "I went to one of the first STEM high schools here in [Midwestern state]. I took a lot of dual-enrollment courses [for both college and high school credit] in high school." These quotes can be interpreted as a way these participants understood themselves as smart within the institutional structure of school (i.e., honors and gifted programs, advanced courses, specialized programs).

In our interviews with first-year engineering students, several participants offered examples of how their identity as smart relates to an affinity-identity view. One such example are the participants who chose to be in engineering living-learning community cohorts. In this case these participants expressed the desire to be in a community model, so that they could have shared experiences with peers related to their engineering education. Jimmy states, "You get access to a better community." Another first-year student, Wyatt, says the following about choosing to join an engineering living-learning community, "If you're going to be taking engineering classes, it's nice to be [living] around engineers. I'm pretty glad I did because I like to be with people." Another example is participants who describe being involved in academic-related extracurricular activities. Emma, a first-year student, describes the impact of robotics club during her senior year of high school,

> I participated in robotics like my whole life. I've always liked being able to explore and build things, and programming [...] I was at the robotics world championship with my robotics team, and it was the final day during the closing ceremonies. It was very emotional, and I was thinking about how I didn't want to leave my team.

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In recognizing that being smart is socially and culturally linked to being an engineer or participating in engineering activities, the above quotes can be interpreted as examples of affinity-identities related to engineering and by participating in these groups one would consequently be identified as smart.

5. HOLLAND ET AL.'S (1998) FRAMING OF IDENTITY

In their book, *Identity and Agency in Cultural Worlds*, Holland and colleagues (1998) draw on Vygotsky (1978), Bakhtin (1982), and Bourdieu (1977) to argue that a framing of identity that focuses on either the influence of culture on an individual's identity (culturalist view) or the individual's internal or psychological navigation of social context to negotiate identity (constructivist view) is insufficient. Specifically, they point out that either framing fails to account for the agency they observed individuals demonstrating in the process of identity construction during their field work (Holland et al., 1998). While culture and social norms certainly matter for individuals as they construct identities, they argue that we are never direct replicas of our culture or of our processes for navigating social context. In their more holistic framing of identity, they invoke the idea of "figured worlds," which they describe as "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). Their idea is that we are always participating in multiple figured worlds, and it is through that participation that we learn to understand ourselves. A figured world can be any cultural practice that has its own rules, guidelines, and social forces that influence (but do not dictate) how people behave, speak, and conduct practice within a given social space. The practices within a figured world are facilitated by artifacts and discourse and are also subject to larger social structures of power and privilege. Therefore, individuals are understood to develop identity through participation in a figured world where they are both subject to being "figured" by the societal and local social norms, and capable of improvising ways to navigate those norms. The result is not just an identity, but a positional identity. Individuals understand themselves not in isolation, but relative to others.

For example, one could consider undergraduate engineering education to be a figured world. Clearly, engineering education is a context with its own history and social norms. Distinct artifacts (e.g., exams, grades, curves, study groups) and discourses (e.g., the ways people talk about the amount of work required to excel in engineering or discourse about who belongs in engineering) exist. As students enter their undergraduate studies, they bring their own histories and positions within larger societal structures (e.g., racial and gender identities) that inform how they participate. Through participation in undergraduate education, engineering students then construct their understanding of who they are as engineering students by embodying the cultural practices of the figured world to some degree. Societal structures (e.g., power hierarchy between different roles in higher education) and privileges (e.g., dominant groups are recognized as smarter than non-dominant groups) remain influential as students develop their identity related to being an engineering student. Finally, this framing of identity would say that students in undergraduate engineering education are not just constructing their identities as engineers on some independent scale, but rather they are constructing their identities as engineers based on how much more or less of an engineer they are than the others in the figured world.

Holland et al.'s (1998) framing of identity has been used in engineering identity research, including two foundational studies. First, Tonso (2007) drew on Holland and colleagues' (1998) framing of identity to unpack the complex sociocultural processes of becoming an engineer. Tonso (2007) argued that these processes cannot be understood without consideration for the intertwined relationships between engineering knowledge, engineering identity, gender, and power relations. In line with Holland et al., she described identity as the "link between the personal realm and the collective understanding embedded in culture, made evident in cultural types, and played out in social relations" (Tonso, 2007, p. 26). Additionally, Stevens et al. (2008) drew on Holland and colleagues' identity framing (1998) to generate an analytical framework for "becoming an engineer." As such, they stated that students are simultaneously negotiating their identity as engineers by positioning themselves and being positioned by others within the context of their engineering education.

5.1 SMART AND HOLLAND ET AL.'S FRAMING OF IDENTITY

The integration of "smart" into research on engineering identity when framed by Holland and colleagues (1998) can be directly informed by existing work from Hatt (2012). Hatt (2012) used Holland and colleagues' (1998) framing of identity to articulate what she discovered during her ethnographic observations in a kindergarten classroom. In short, she argues that smartness itself is its own figured world, and, in fact, the most pronounced and critical cultural practice in schooling (Hatt, 2012). In this way, we can understand smartness not as within students in a biological sense, but instead as "initially located outside students—culturally produced—before moving through students as spoken discourse and embodied practice" (Hatt, 2012, p. 442).

Smartness "becomes a dynamic concept experienced by people through identity construction" (Hatt, 2012, p. 439). Hatt (2012) demonstrated that in the educational context of her work, the figured world of smartness had salient artifacts, which included a large stoplight in the classroom where each child had a car and its movement from green to yellow to red was used to indicate displays of inappropriate behavior. Through her interviews with students in the classroom, she learned that every student defined smart as "not having to move your car" (Hatt, 2012, p. 448). Smartness was also practiced through discourse in the classroom. Teachers explicitly told students that they would "get very smart" if they listened to the teacher (Hatt, 2012, p. 452). Furthermore, students with prior knowledge of the material being taught (e.g., those who already knew how to count to high numbers) were often called "geniuses" or told they were "so smart" (Hatt, 2012, p. 453). Those positioned as the smartest in the classroom gained access to social power (e.g., popularity, release from teacher supervision, and leadership roles in the classroom), which demonstrates that smartness operated as a tool of social positioning (Hatt, 2012). Furthermore, the process ascribed "social power defined along lines of class and race" (Hatt, 2012, p. 439).

Framing smartness as a cultural practice means recognizing that the individuals within an educational situation are participating in smartness as a cultural practice. As students participate, they are co-constructing shared beliefs about what types of behavior constitute smart, and they are navigating their own positional identity as smarter (or less smart) relative to other students (Hatt, 2012). As a cultural practice, smartness relies on implicit negotiation of what it means to think or act intelligently within local contexts and larger systems of power and privilege (Hatt, 2007, 2012). Therefore, what counts as smart behavior and who gets counted as smarter than others is contextual and can vary in broad or in nuanced ways based on the given culture, time, or place where the cultural practice occurs.

5.2 EXAMPLES FROM OUR EMPIRICAL WORK

Throughout our empirical work we found examples for how students are understanding themselves as smart within the context of undergraduate engineering in ways that align with Holland et al.'s (1998) framing of identity and concept of figured worlds. First, we found examples of how the idea of "smart" appeared throughout the artifacts and discourse used by undergraduate engineering students that resulted in positional identities (i.e., how they understand themselves relative to others). We noticed that the artifact of grades was used when participants were describing themselves. For example, Cameron, a young woman in her first year explains how her performance in math classes (i.e., good grades) was how she understood herself to be smart enough for engineering stating, "I was always in the highest math class and performed well amongst my peers, and so I felt like I could just continue that same momentum through engineering." Similarly, Hailey, another young woman in her first year, replied, "I think it's the good grades because it's a tangible kind of thing that you can see how you're doing compared to others in your class" when asked how she knows who's smart in her engineering classes.

Similar to what we presented in the section on Gee (2000) regarding discourse, we also noticed explicit examples of how discourse is used by undergraduate engineering students to understand themselves as smart relative to others. For example, Skylar, also a young woman in the first-year engineering program, described how there is a general understanding that engineering is harder (and therefore better) than other majors:

> I think there's just that general sense about STEM majors, particularly engineering [...] thinking that engineering's the hardest major there is and how we're so much better than arts and science.

Further, revisiting the quote from Anna presented in Section 4.2, it illustrates the discourse used by engineering students to "make fun" of business students and position themselves as "smarter."

According to Holland et al. (1998), the practices within a figured world are subject to larger social structures of power and privilege and in our empirical data we found examples of how power and privilege influence how student understand themselves as smart. For example, Anna spoke candidly about coming to terms with the role of privilege in her pre-college experiences and how that shaped how she learned to understand herself as smart. Specifically, she spoke about her privilege in attending a well-funded public school and being institutionally recognized as smart. When asked when she first understand herself as smart enough for engineering, she said:

> Probably high school [...] I recognize that I come from a very privileged background and being able to attend the school I did. I was very sheltered growing up, so I didn't realize that the education that I got at [her high school] was not the same [...] I literally thought that every single school in America had the exact same type of education that I got.

Finally, gaining access to social power and resources is an outcome of the way in which social positioning occurs within a figured world (Holland et al., 1998). Empirical evidence from a prior study indicates that undergraduate engineering students do indeed talk about the importance of being recognized as smart and believe that being recognized as smart enables access to necessary resources (e.g., scholarships, letters of recommendations) (Dringenberg et al., 2022).

6. CONCLUSION

In this paper, we argue that in engineering identity research, regardless of the fundamental identity theory or framework being used, "smart" should be integrated as students are simultaneously understanding themselves as smart and as an engineer within the context of engineering education. We made a theoretical argument by demonstrating how "smart" integrates with three framings of identity used in engineering education research. We further bolstered our claim that "smart" should be integrated into work related to engineering identity by providing examples of the concrete ways in which engineering students understand themselves as smart and how this relates to being an engineering student. Both theory and empirical examples illustrate the deep connection between how students understand themselves as smart and how they identify as engineers in the context of students' engineering education experiences. Ultimately, we find integrating "smart" in framing engineering identity as important for future engineering identity research.

Finally, although we argue that how students understand themselves as smart must be made explicit in engineering identity research, we are not arguing that we should accept how "smart" functions in engineering as status quo. We recognize smartness as an oppressive cultural practice (Hatt, 2007, 2012; Leonardo & Broderick, 2011). The reality that students' identities as smart are so interwoven with their identities as engineers can have very negative consequences. While being considered smart is typically a positive thing in society, the perception that engineering is only for the smartest students has direct links to the lack of diversity and inclusion within the field (Carroll et al., 2019) because being identified as smart acts as a mechanism to stratify privilege in classrooms. As Leonardo and Broderick (2011) argue:

> A substantial part of the ideological work of schooling constructs and constitutes some students as "smart," while simultaneously constructing and constituting other students as "not-so-smart"—that is, some students are taught their intellectual supremacy and concomitant entitlement to cultural capital, whereas others are taught their intellectual inferiority and concomitant lack of entitlement to both an identity as a "smart" person, and the cultural and material spoils that such an identity generally affords (p. 2214).

As mentioned throughout this paper, numerous studies that have found that the pervasive practice of tracking students, or grouping them by perceived ability, particularly in American K–12 educational systems, is a racist, gendered, and classed practice that creates inequity (Nunn, 2014; Oakes, 2005). Additionally, the assumption that engineering requires exceptional intellectual or academic ability drives aspects of students' experiences and academic decisions (Anderson-Rowland et al., 2013; Besterfield-Sacre et al., 1997). Therefore, our argument for making "smart" an explicit consideration in engineering identity research is not only theoretically and empirically sound, but also a strategic way to reveal the oppression that contributes to the exclusionary nature of engineering under the guise of ability.

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The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Braaten, Kramer, Dringenberg, and Kajfez co-generated the concept for this paper. Braaten and Dringenberg authored the first draft of most sections of the paper, while Kramer and Kajfez supported with drafting smaller sections and revisions. Kramer led most of the second draft revisions and rewriting of the paper, while Dringenberg, Kajfez, and Braaten supported with revisions. The final draft was led by Braaten and Kramer, while Dringenberg and Kajfez supported with rewrites and revisions.

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REFERENCES

Anderson-Rowland, M. R., Rodriguez, A. A., & **Grierson, A.** (2013). *Why some community college students choose engineering and some don't.* 2013 ASEE Annual Conference & Exposition. DOI: https://doi.org/10.18260/1-2--22756

Bakhtin, M. M. (1982). *The dialogic imagination: Four essays* (M. Holquist & C. Emerson, Trans.). University of Texas Press.

Besterfield-Sacre, M., Atman, C. J., & **Shuman, L. J.** (1997). Characteristics of freshman engineering students: Models for determining student attrition in engineering. *Journal of Engineering Education*, *86*(2), 139–149. DOI: https://doi.org/10.1002/j.2168-9830.1997.tb00277.x

Bourdieu, P. (1977). *Outline of a theory of practice* (R. Nice, Trans.). Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511812507

Burke, P. J., Owens, T. J., Serpe, R. T., & **Thoits, P. A.** (2003). *Advances in identity theory and research*. Springer. DOI: https://doi.org/10.1007/978-1-4419-9188-1

Burke, P. J., & **Stets, J. E.** (2022). *Identity theory: Revised and expanded*. Oxford University Press. DOI: https://doi.org/10.1093/oso/9780197617182.001.0001

Capobianco, B. M., French, B. F., & **Diefes-Du, H. A.** (2012). Engineering identity development among pre-adolescent learners. *Journal of Engineering Education*, *101*(4), 698–716. DOI: https://doi.org/10.1002/j.2168-9830.2012.tb01125.x

Carlone, H. B., & **Johnson, A.** (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 44(8), 1187–1218. DOI: https://doi.org/10.1002/tea.20237

Carroll, T., Kramer, A., & **Dringenberg, E.** (2019). *Intelligence and smartness in engineering: A Gatekeeper to Diversity and Inclusion*. Crystal City, Virginia: The Collaborative Network for Engineering and Computing Diversity.

Curtis, B., Smaller, H., & **Livingstone, D.** (1992). *Stacking the deck: The streaming of working-class kids in Ontario schools* (Vol. 24). James Lorimer & Company.

Dringenberg, E., Kramer, A., & **Betz, A.** (2022). Smartness in engineering education: Undergraduate student beliefs. *Journal of Engineering Education*, *111*(2), 283–307. DOI: https://doi.org/10.1002/jee.20463

Dweck, C. (2006). *Mindset: The new psychology of success*. Random House.

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. Psychology Press.

Eliot, M., & **Turns, J.** (2011). Constructing professional portfolios: Sense-making and professional identity development for engineering undergraduates. *Journal of Engineering Education*, *100*(4), 630–654. DOI: https://doi.org/10.1002/j.2168-9830.2011.tb00030.x

Gee, J. P. (2000). Chapter 3: Identity as an analytic lens for research in education. *Review of Research in Education*, *25*(1), 99–125. DOI: https://doi.org/10.3102/0091732X025001099

Geisinger, B., Raman, D. R., & **Raman, D.** (2013). Why they leave: Understanding student attrition from engineering majors. *International Journal of Engineering Education*, *29*(4), 914–925. https://www.ijee.ie/latestissues/Vol29-4/14_ijee2746ns.pdf

Godfrey, E., & **Parker, L.** (2010). Mapping the cultural landscape in engineering education. *Journal of Engineering Education*, *99*(1), 5–22. DOI: https://doi.org/10.1002/j.2168-9830.2010.tb01038.x

Godwin, A. (2016). *The development of a measure of engineering identity* [Paper Presentation]. 2016 ASEE Annual Conference & Exposition, New Orleans, LA. DOI: https://doi.org/10.18260/p.26122

Godwin, A., Potvin, G., Hazari, Z., & **Lock, R.** (2016). Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice. *Journal of Engineering Education*, *105*(2), 312–340. DOI: https://doi.org/10.1002/jee.20118

Hatt, B. (2007). Street smarts vs. book smarts: The figured world of smartness in the lives of marginalized, urban youth. *The Urban Review*, *39*(2), 145–166. DOI: https://doi.org/10.1007/s11256-007-0047-9

Hatt, B. (2012). Smartness as a cultural practice in schools. *American Educational Research Journal*, *49*(3), 438–460. DOI: https://doi.org/10.3102/0002831211415661

Hazari, Z., Sonnert, G., Sadler, P. M., & **Shanahan, M. C.** (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*(8), 978–1003. DOI: https://doi.org/10.1002/tea.20363

Holland, D., Lachicotte, W., Jr., Skinner, D., & **Cain, C.** (1998). *Identity and agency in cultural worlds*. Harvard University Press.

Huff, J. L., Okai, B., Shanachilubwa, K., Sochacka, N. W., & **Walther, J.** (2021). Unpacking professional shame: Patterns of White male engineering students living in and out of threats to their identities. *Journal of Engineering Education*, *110*(2), 414–436. DOI: https://doi.org/10.1002/jee.20381

Kajfez, R., Kramer, A., Braaten, B., & **Dringenberg, E.** (Forthcoming). Am I smart enough to be an engineer? How undergraduate engineering students articulate their identification with smartness. *Manuscript in Development*.

Kramer, A., Braaten, B., Kajfez, R. L., & **Dringenberg, E.** (2021). *Who's Smarter? Beliefs about Smartness and Self-Identities Across Institutionalized Educational Pathways into Engineering.* 2021 ASEE Virtual Annual Conference Content Access.

Leonardo, Z., & **Broderick, A.** (2011). Smartness as property: A critical exploration of intersections between whiteness and disability studies. *Teachers College Record*, *113*(10), 2206–2232. DOI: https://doi.org/10.1177/016146811111301008

Leslie, S.-J., Cimpian, A., Meyer, M., & **Freeland, E.** (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*(6219), 262–265. DOI: https://doi.org/10.1126/science.1261375

Morelock, J. R. (2017). A systematic literature review of engineering identity: Definitions, factors, and interventions affecting development, and means of measurement. *European Journal of Engineering Education*, *42*(6), 1240–1262. DOI: https://doi.org/10.1080/03043797.2017.1287664

National Academy of Engineering. (2008). *Changing the conversation: Messages for improving public understanding of engineering*. National Academies Press.

Oakes, J. (2005). *Keeping track*. Yale University Press. DOI: https://doi.org/10.1126/stke.2772005tw114

Okagaki, L., & **Sternberg, R. J.** (1993). Parental beliefs and children's school performance. *Child Development*, *64*(1), 36–56. DOI: https://doi.org/10.1111/j.1467-8624.1993.tb02894.x

Paretti, M. C., & **McNair, L. D.** (2012). Analyzing the intersections of institutional and discourse identities in engineering work at the local level. *Engineering Studies*, 4(1), 55–78. DOI: https://doi.org/10.1080/19378629.2011.652120

Patrick, A., & **Borrego, M.** (2016). *A review of the literature relevant to engineering identity.* American Society for Engineering Education Annual Conference, New Orleans, Louisiana. DOI: https://doi.org/10.18260/p.26428

Patrick, A. D., Prybutok, A., & **Borrego, M.** (2018). Predicting persistence in engineering through an engineering identity scale. *International Journal of Engineering Education*, *34*(2a), 351–363. DOI: https://doi.org/10.15781/T2ZC7SB9J

Pierrakos, O., Beam, T. K., Constantz, J., Johri, A., & **Anderson, R.** (2009). *On the development of a professional identity: Engineering persisters vs. engineering switchers.* IEEE Frontiers in Education Conference, San Antonio, TX. DOI: https://doi.org/10.1109/FIE.2009.5350571

Rattan, A., Savani, K., Naidu, N., & **Dweck, C. S.** (2012). Can everyone become highly intelligent? Cultural differences in and societal consequences of beliefs about the universal potential for intelligence. *Journal of Personality and Social Psychology*, *103*(5), 787. DOI: https://doi.org/10.1037/a0029263

Rodriguez, S. L., Lu, C., & **Bartlett, M.** (2018). Engineering identity development: A review of the higher education literature. *International Journal of Education in Mathematics, Science and Technology*, *6*(3), 254–265. DOI: https://doi.org/10.18404/ijemst.428182

Ross, M. S., Huff, J. L., & **Godwin, A.** (2021). Resilient engineering identity development critical to prolonged engagement of Black women in engineering. *Journal of Engineering Education*, *110*(1), 92–113. DOI: https://doi.org/10.1002/jee.20374

Secules, S., Gupta, A., Elby, A., & **Turpen, C.** (2018). Zooming out from the struggling individual student: An account of the cultural construction of engineering ability in an undergraduate programming class. *Journal of Engineering Education*, *107*(1), 56–86. DOI: https://doi.org/10.1002/jee.20191

Sfard, A., & **Prusak, A.** (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. *Educational researcher*, *34*(4), 14–22. DOI: https://doi.org/https://doi.org/10.3102/0013189x034004014

Sochacka, N., Walther, J., Wilson, J., & **Brewer, M.** (2014). *Stories 'told' about engineering in the media: Implications for attracting diverse groups to the profession.* 2014 IEEE Frontiers in Education Conference (FIE) Proceedings, Madrid, Spain. DOI: https://doi.org/10.1109/FIE.2014.7044009

Sternberg, R. J. (2002). What does it mean to be smart? *California Journal of Science Education*, 99.

Sternberg, R. J. (2004). Culture and intelligence. *American Psychologist*, *59*(5), 325. DOI: https://doi.org/10.1037/0003-066X.59.5.325

Sternberg, R. J. (2007). Who are the bright children? The cultural context of being and acting intelligent. *Educational Researcher*, *36*(3), 148–155. DOI: https://doi.org/10.3102/0013189X07299881

Stevens, R., Amos, D., Jocuns, A., & **Garrison, L.** (2007). *Engineering as lifestyle and a meritocracy of difficulty: Two pervasive beliefs among engineering students and their possible effects.* ASEE Annual Conference and Exposition, Conference Proceedings. DOI: https://doi.org/10.18260/1-2--2791

Stevens, R., O'Connor, K., Garrison, L., Jocuns, A., & **Amos, D. M.** (2008). Becoming an engineer: Toward a three-dimensional view of engineering learning. *Journal of Engineering Education*, *97*(3), 355–368. DOI: https://doi.org/10.1002/j.2168-9830.2008.tb00984.x

Tonso, K. L. (2007). *On the outskirts of engineering: Learning identity, gender, and power via engineering practice*. Brill. DOI: https://doi.org/10.1163/9789087903534

Vignoles, V. L., Schwartz, S. J., & **Luyckx, K.** (2011). Introduction: Toward an integrative view of identity. In *Handbook of identity theory and research* (pp. 1–27). Springer. DOI: https://doi.org/10.1007/978-1-4419-7988-9_1

Vygotsky, L. S. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.

Weiner, S., Lande, M., & **Jordan, S.** (2018). The engineer of 2020, in the making: Understanding how young adults develop maker identities and the implications for education reform. *International Journal of Engineering Education*, *34*(2), 833–842. https://www.ijee.ie/latestissues/Vol34-2B/26_ijee3601.pdf

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