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A Gendered "Ideal?" Discourses that Characterize the Ideal Scientist

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ABSTRACT
Using the framework of Acker's (1990, 2012) theory of gendered organizations, this study constructs and then deconstructs the notion of the ideal scientist. This is done by identifying the discourses and practices that guide the process of becoming a scientist or mathematician. Data collected from 15 participants via semi-structured interviews focused on identifying and describing the work involved in choosing to become a scientist or mathematician by exploring participant experiences in K-12 education and then day-to-day higher education studies. The findings suggest that the notion of an ideal scientist is defined according to masculine discourses such as independence and ability as fixed. Notions of an ideal scientist created expectations that were described as challenging by women student participants who reported being reluctant to speak up in class and feared confirming stereotypes.

KEYWORDS
STEM higher education; institutional ethnography; women in STEM; gendered organizations, ideal worker

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INTRODUCTION

Science, technology, engineering, and mathematics (STEM) higher education degree programs aim to teach students content area knowledge and skills. In addition, and as a part of that process, faculty and fellow students convey what it looks like to be a scientist. Learning in STEM in higher education represents a "historically specific mode of coming to know the world around [one] [based on the discourses of the] ideological forms and appearances" (Carpenter, 2012, p. 30) of the specific STEM content areas. Through instructional documents, assignment expectations, classroom behavior, advising, and mentoring, STEM programs communicate an ideal to students that sets expectations for how they should behave, look, feel, and think (Parson & Ozaki, 2017). This ideal is guided by dominant STEM discourses like individualism, competition, knowledge defined as objective, and ability as fixed (Parson & Ozaki, 2017).

However, these ideals are problematic because they are usually presented as objective and unbiased when the reverse is true; they are indeed biased. Notably, the notion of an ideal scientist is only achievable by a cisgendered few (Parson & Ozaki, 2017). Undergraduate and graduate STEM programs are the primary location where students are socialized to learn the culture, values, attitudes, and expectations of their academic disciplines, and this socialization impacts a student's sense of belonging (Austin, 2002; De Welde & Laursen, 2011; Sallee, 2014). If the socialization process communicates to students that they must achieve an ideal that requires them to reject knowledge(s) or behave in a way that is incompatible with their beliefs and values, that ideal, along with the chilly climate (Herzig, 2004; Litzler, Lange, & Brainard, 2005), may lead those students to leave, even if their interest in the field of study remains high.

The purpose of this study is to gain a better understanding of the discourses and practices that construct the concept of the ideal scientist and mathematician. Second, we seek to understand if and how these discourses and associated practices create challenges for women students in STEM higher education in the fields of mathematics, physics, and computer science (CS). Through the application of Acker's (1990; 2012) theory of gendered organizations, we interviewed undergraduate and graduate STEM students at two institutions, an international institution and an institution located in the United States, to better understand how they construct the ideal scientist through discourses about choosing to become a scientist and the work that goes into becoming a scientist. Then, we set out to identify if and how those expectations are gendered, and if so, how they create challenges for women students in particular.

THE GENDER GAP IN STEM HIGHER EDUCATION

Although the gender gap has narrowed in the United States, particularly for white women (Ong et al., 2011), women as a collective continue to be underrepresented in most STEM fields (Wong, 2015). Women and persons of color are also more likely to change majors to a non-STEM field, less likely to pursue a graduate STEM degree, and choose to pursue a career in a field outside of STEM after graduation (Barthelemy et al., 2015; DeWelde & Laursen, 2011; Ong et al., 2011). This contributes to a persistent gender and race gap in STEM careers (De Welde & Laursen, 2011).

Gender gaps in STEM higher education enrollment and persistence are reported across fields of study and educational degree level (undergraduate and graduate). Notably, fewer women enroll in and graduate with STEM degrees (Blackburn, 2017). This is especially true for STEM fields that begin with mathematics coursework, such as mathematics, CS, and physics (Herzig, 2004; Chao & Cohoon, 2010; Good et al., 2012).

Persons who identify as women, non-binary persons, and persons of color are often alienated in higher education where "white, [man], Western cultural norms of individuality, debate, and competitiveness, which are antithetical to the norms of many other cultures, dominate the classroom environment" (Baumgartner & Johnson-Bailey, 2008, p. 46). For example, discourse analysis of STEM education institutional texts found that certain discourse use reinforces gendered binaries including men/women, lazy/hard worker, competition/collaboration, and active/passive (Allen, 2003; Yakaboski, 2011). These binaries place cisgender men at the center, with women and their actions continually referenced as off-center or as recognizable and definable by their difference from men (Yakaboski, 2011).

Challenges for women students are created by the discourses that are prevalent within STEM, such as individualism (Leathwood, 2006), competition (Sallee, 2014), a willingness to fail (Simpson & Maltese, 2017), and the mentality that ability is fixed (Covarrubias et al., 2019). Indeed, research shows that student ideals and expectations that are guided by these discourses are gendered, racialized, and classed and contribute to a decreased sense of belonging in STEM for women (Blackburn, 2017). Dominant discourses in STEM education include 1) ability as fixed, or the belief that ability is innate or biological and cannot be learned; 2) individualism, a focus on individual responsibility for achievement; 3) competition, a focus on achieving over or more than others; and 4) difficulty, the sense that science and math work must be prohibitively challenging (Parson & Ozaki, 2017). These discourses can impact women student's sense of belonging and scientific self-efficacy due to the dominant discourses within STEM education that point to a masculine science ideal (Leathwood, 2006; Sallee, 2014; Gonsalves, 2014; Parson & Ozaki, 2017). For example, another STEM education discourse, independence, posits that students should be self-reliant, autonomous, self-driven, and ambitious, but these characteristics are traditionally categorized as masculine (Leathwood, 2006). In order to be independent, one must be "unencumbered" or free from responsibilities like a family, employment, financial access, or imposter syndrome (Leathwood, 2006, p. 615). Thus, the idealized STEM independent learner is inherently masculine, middle-class, and able-bodied (Leathwood, 2006).

These ideals can create challenges for women students by communicating to women that asking for help is inappropriate or incompatible with being a successful

STEM student (Parson & Ozaki, 2017). The gendered organization creates expectations that are presented as natural and normal when, in reality, they are gendered (Acker, 1990). The expectations created by these discourses creates an ideal scientist that can contribute to a decreased sense of belonging or a perception that one's gender is incompatible with STEM (Ahlqvist et al., 2013; Good et al., 2012; Sallee, 2014; Griffin et al., 2015; Parson & Ozaki, 2017). Indeed, Beutel et al. (2018) found that women who were more likely to conform to "feminine" norms were less likely to major in a STEM field.

Current efforts at gender parity in STEM in the United States focus on recruitment and enrollment, but a gap in retention and persistence still exists (Blackburn, 2017). The decrease in women's persistence throughout one's STEM career can be described as a "leaky pipeline," (Blackburn, 2017; Blickenstaff, 2015; Vitores & Gil-Juárez, 2016). This "leaky pipeline" metaphor does little to explain how women are leaving STEM and instead perpetuates the myth that women are not good enough or do not belong in STEM, and as a consequence, leave. This metaphor suggests an unfounded deficit in women's STEM ability rather than an issue with the current STEM institution or culture. This can place a burden on women to conform to the STEM culture or risk being pushed out, when in reality, the informal STEM culture positions women as outsiders and creates ideals that results in challenges for students (De Welde & Laursen, 2011).

With this research, we aim to provide a better understanding of how the institution creates or reinforces the concept of an "ideal" scientist or mathematician by understanding how those discourses create barriers for women students. We do this by exploring the discourses that surround undergraduate and graduate STEM students across two higher education institutions. Such discourses, we argue, can create a level of discomfort or can push these individuals to leave.

THEORETICAL FRAMEWORK

We framed this study through the application of Acker's (1990, 2012) theory of gendered organizations. Gendered organizations refer to organizational structures and practices that favor one gender over another (Hart, 2016; Lester et al., 2017; Mars & Hart, 2017); typically, gendered organizations are conceptualized in such a way to represent organizations as masculine. Organizations are gendered through three substructures: organizational subtexts; culture; and, the ideal worker (Hart, 2016; Mars & Hart, 2017). Five interacting processes underpin these substructures:

> (a) construction of divisions along lines of gender, (b) construction of symbols and images, (c) production of gendered social interactions, (d) creation of gendered components of individual identity, and (e) implicit and fundamental creation and conceptualization of gendered social structures (Lester et al., 2017, p. 2).

These five interacting processes also construct and communicate the ideal to workers, or in the case of our study, to higher education STEM students.

In this research, we sought to understand how the third substructure, the ideal worker, specifically the ideal scientist or mathematician, is shared with students through institutional practices and discourses. By identifying the discourses that coordinate the work of choosing to become a scientist or a mathematician, we seek to better understand if and how the institutional discourses and processes that coordinate their work continue to support the oppression of women (Harding, 2009; Smith, 2000).

Prior research did explore how higher education is a gendered organization that disadvantages community college students (Madden, 2018), STEM women undergraduates (Parson & Ozaki, 2017), and STEM women faculty (Hart, 2016). In this study, we extend our knowledge of how the STEM gendered organization creates challenges for STEM students by describing the ideal scientist as constructed by faculty and students, and by providing insight into how this ideal creates particular challenges for women in STEM higher education.

METHODS

Data Collection

We collected data through the use of semi-structured interviews with undergraduate and graduate students in two higher education STEM institutions, one international. The data reported on in this manuscript is a subset of the data collected in two larger institutional ethnographies (See Steele et al., 2020; Parson & Steele, 2020). In this manuscript, we focused on the data collected from student participants in both studies that informed understanding of how their experiences as STEM students were coordinated by the ideal of a scientist or mathematician. Specifically, our research questions sought to understand:

1. Why do STEM students choose to pursue a STEM career?
2. How do STEM students conceptualize the expectations of what it means to be a scientist or mathematician?
3. Do these expectations create challenges for women students? If so, how?

Data collection in both studies applied the institutional ethnographic data collection procedures outlined by Smith (2005), which begins with collecting entry-level data, which seeks to identify details about participant’s daily activities. Those details inform the second stage of data collection that seeks to identify how that work is coordinated via additional interviews, observations, and identification of coordinating texts.

Interview questions consisted of broadly asking STEM students to describe the everyday work of being an undergraduate or graduate student in the field of physics, CS, or mathematics. There were two phases for the data collection activities. The initial data collection focused on identifying the day-to-day work involved in becoming a scientist or mathematician. Following an iterative process of data collection and analysis, subsequent data collection activities guided the identification of the discourses specific to the STEM institution.

Participants

Potential participants were recruited via email to mathematics and science students, posts to student organization listservs, and included in a bulletin sent to new students. Demographically speaking, participants included those who identified as women, men, and one student who identified as non-binary. Because we were seeking to focus on discourses coordinating student work that may differentially impact women, we also included men in our recruitment and participation sample. In other words, participants did not have to self-identify as being part of the marginalized group to be able to contribute to this research. Interest in gender bias in STEM was also not a participation requirement; however, two participants (Shannon and Margaret; pseudonyms) indicated during the interview process that they chose to signal their interest in participating because they were aware of gender biases in STEM.

Table 1: Description of Participants

Pseudonym	Major	Grade Level/Status	Pronouns	Institution	Number of Interviews
Amanda	CS	Freshman	She/Her	SU	3
Andras	Math	Graduate/ Master's/2nd year	He/Him	IU	1
Benjamin	Math	Graduate/ Master's/1st year	He/Him	IU	1
Christian	Math	Graduate/ Master's/1st year	He/Him	IU	1
Diane	CS	Freshman	She/Her	SU	3
Erika	Math	Graduate/PhD/ 1st year	She/Her	IU	1
Furkan	Math	Graduate/PhD/ 1st year	He/Him	IU	1
Jen	Physics	Freshman	She/Her	SU	3
Kalman	Math	Graduate/ Master's/1st year	He/Him	IU	1
Laci	Math	Graduate/PhD/ 2nd year	She/Her	IU	1
Margaret	CS/ Engineering	Freshman	She/Her	SU	3
Meg	CS	Sophomore	She/Her	SU	3
Shannon	Physics	Freshman	They/Them	SU	2
Szabolcs	Math	Graduate/ Master's 2nd year	He/Him	IU	1
Tamas	Math	Graduate/ Master's/2nd year	He/Him	IU	1

The final number of study participants totaled 15 STEM undergraduate and graduate students from the fields of physics, CS, and mathematics from two institutions (IU and SU) (see Table 1). There were seven women, seven men, and one individual who self-identified as non-binary. Each participant met with the interviewer in one to three interviews (26 interviews total). We chose to focus specifically on the fields of mathematics, CS, and physics because these fields historically graduate fewer women: 39.3%, 21%, and 20.3% of all 2016 graduates (undergraduate and graduate combined) were women, respectively (statistics obtained via the DATAUSA Comparison Tool that analyzes IPEDS 2016 data; accessed at datausa.io). The inclusion of both undergraduate and graduate students provides insights into how discourses are prevalent throughout STEM higher education.

Data Analysis

We followed Carspecken's (1996) critical ethnography coding process to analyze collected data. Our goal was to provide insight into how institutions coordinate the day-to-day lives of marginalized or minoritized persons through discourse. By following a critical ethnographic approach to coding, we attempted to reconstruct "cultural and subjective factors that are largely tacit in nature" into "explicit discourse" (Carspecken, 1996, loc 2376). This approach guided our coding process as we sought to identify the everyday discourses that influence STEM students' work.

The critical ethnographic coding process began with low-level coding, which included structural and open coding (Saldaña, 2016). Low level codes were largely descriptive and described their day-to-day work and challenges by student participants. Those low-level codes directed future data collection that sought to understand what practices and discourses were coordinating the work and challenges identified by participants. High-level coding followed the final stage of data collection.

After all interviews were complete, high-level coding assisted in identifying or "reconstructing" the discourses that coordinated the practices and discourses identified in low-level coding. Data analysis was complete when saturation was reached, and when no new themes emerged (Saldaña, 2016). Themes identified included discourses of ability as fixed, knowledge as disconnected from "real life", and stereotype threat. Once coding was complete, codes were synthesized into categories and themes through code reorganization (Carspecken, 1996). Codes were grouped into categories according to the research questions and then organized by the discourses of an ideal scientist of mathematician that coordinated the students' work of becoming a scientist or a mathematician.

Ethics and Validity of Findings

Interviews used for the data analysis were conducted with approval from the respective Institutional Review Boards (IRB) of the first author's place of employment at the time the studies were completed. In line with these approvals, pseudonyms were used for institutions and participants to ensure confidentiality. Validity of results was achieved through triangulation with the literature and triangulation with other student participants in this study. In Parson & Steele (2020), we reported on another part of the institutional ethnography conducted at IU, the international university included in this manuscript, focusing on the ways institutional structures at the national, local, and organizational level created challenges for students through institutional processes. That paper also discussed STEM discourses, specifically exploring how the discourses of difficulty, individualism, and competition created challenges for students. In the present manuscript, we expand our conversation about discourses to focus on how STEM institutional discourses create an ideal scientist/mathematician that is introduced to students prior to their higher education experiences and is then reinforced throughout higher education. We include the data from both IU and SU (the institution located in the United States) studies to demonstrate how the concept of an ideal scientist and mathematician is reinforced across STEM fields, levels of education, and countries.

Although the aim of this research was focused on understanding how gendered ideals create challenges for women participants, collection of data from participants who identified as men reinforced perceptions of the discourses identified by women and the sole non-binary participant. This approach provided a certain level of validity with respect to our analysis, and the resultant findings. Given the small sample size, however, generalizations are not possible nor were they the goal of this study.

FINDINGS

Applying Acker's (1990) gendered organization theory, as presented previously, as our lens, we were able to explore how seeking to become an ideal scientist can coordinate the experiences of STEM students through discourses and practices prevalent in STEM higher education. We looked for, in particular, if and how these ideals are gendered, if at all. Across the two different institutions studied, IU and SU, three fields of study (physics, CS, and mathematics), and two enrollment types (undergraduate and graduate), the analysis suggests that participants had experiences prior to entering into STEM higher education that informed their understanding of an ideal scientist and led them to decide to pursue these studies. The experiences prior to higher education introduced discourses of independence, ability as fixed, scientific knowledge as disconnected from the real world, and STEM as masculine. These discourses are considered in turn below.

These discourses appear to guide the expectations that later become the ideal scientist that participants measured themselves against in higher education. Furthermore, the discourses are reinforced in their STEM higher education experiences. This reinforcement creates challenges for women participants when they struggle to meet those ideals or feel like they are not represented in the ideal which is reflected in stereotype threat.

Following our discussion of the discourses, we discuss the challenges reported by women and non-binary participants in the work of becoming an ideal scientist in higher education. To understand if and how participants' notion of the ideal scientist was gendered, we discuss how the discourses that informed participant's notion of an ideal scientist created challenges for women student participants. Study participants identified as men, women, and non-binary. Experiencing the effects of a discourse does not, on its own, mean that the discourse or ideal is gendered. Further, men can also experience gendered discourses in ways that can have harmful impacts on their sense of well-being, belonging, and persistence (Weaver-Hightower, 2011). We discuss the implications of those challenges reported by women participants on the nature of these discourses and how they inform a gendered ideal in the Discussion section.

Independence

The discourses that define the ideal scientist are reinforced throughout K-12 and higher education. Most participants did cite family members and teachers as role models that helped them to understand what it means to be and to look like a scientist. They described this as a reason that they decided to pursue a STEM career. Their experiences in K-12 education reinforced and extended those ideals as it exposed them to STEM fields. These role models and experiences helped to inform each participant's understanding of what a scientist looked like and then built a foundation for the ideals that participants would measure themselves against and return to as they decided to pursue a career as a scientist or not.

For example, CS major Meg's father involved her in his work which helped her to see CS as a puzzle and that this work could be fun. This set expectations for Meg, that STEM study should be a fun and enjoyable challenge. Computer engineering major Margaret described how her father taught her that being an engineer required independent hard work. These early exposures to STEM from their parents began to reinforce the discourses of STEM ability as fixed, STEM work as enjoyable, and STEM as independence and requiring hard work.

The independent nature of the ideal scientist continued to coordinate the work of most participants in Higher Education. In their undergraduate STEM courses, all participants described being told that they were expected to work independently on projects and assignments. For example, CS major Amanda described how her professor expected all of the students in her CS class to do their work independently instead of in groups: "he doesn't want to know what your neighbor knows. He wants to know what you know and what you are capable of, which is fair." The discourse of STEM learning as independent continued in graduate education, coordinating the work of participants and reinforcing perceptions of the ideal scientist as independent.

Ability as Fixed

Most participants viewed the ideal scientist as one with natural ability in STEM skills. This perception was reinforced for participants through their own experiences struggling or not struggling in math. Most participants described their reasons for pursuing STEM study because they found math and science easy and enjoyable. When the first author asked all participants why they had chosen to pursue STEM, participants explained that they enjoyed math and science from a young age. Feeling like they were inherently good at math drove many participants to pursue an undergraduate or graduate degree in a STEM discipline that was math heavy.

Similarly, Diane described her decision to pursue CS as a natural or inevitable choice because of her family members that were engineers. This natural or inevitable choice provided a foundation for Diane's perception of STEM ability as fixed.

Most participants also made the distinction that not everyone is good at math, suggesting that they believed mathematics ability is fixed rather than a skill that can be developed with practice. For example, Tamas stated: "I think I have intuition for it. That field of mathematics I can feel I somehow easily understand. I see other people are struggling with, and somehow I can do it." Tamas referred to his innate ability to understand mathematics and assumed that because others were struggling, they were not as inherently good at mathematics like he was. Math graduate student Laci explained: "Not all the people are very good in mathematics. I am very good at it." Laci assumed that her ability to understand mathematics was innate and had more to do with how her brain was wired than a developed skill. These were observations made early in their education that stood out to them because it contrasted with what they observed their fellow students to be struggling with.

However, some women participants did share that they were told by others, usually teachers, that they were not naturally good at math. Amanda explained how a high school teacher believed she was not good at math: "[…] actually, my pre-cal teacher junior year of high school was like 'you're doing your best buddy, but that just isn't your —you're gonna have to, I don't know— do something else. Cause, that's just not how your brain works.'" This teacher reinforced the ideal scientist as one that was naturally good at math. As a result of this conversation with her teacher, Amanda believed that she was not and could never be good at math because she struggled with it. She internalized a fixed mindset towards her own mathematics ability because of messages that she received in high school, and this impacted her self-worth and belief in her own mathematics ability in college.

For some participants, finding something easy that others found challenging became part of their expectations for how they would find all of their coursework. However, a mindset that ability is fixed created challenges for participants when they encountered challenges in their coursework. For example, CS student Amanda described her experience struggling with math that led her to question if she belonged in the degree program. Amanda explained,

> It's made me think long and hard about it. But I think that it's more of, I'm gonna have, like it sucks right now and I'm gonna have to get through it. But I don't think, in practice, I'm not doing pre-cal on the computer, you know what I mean? It's just something that I have to, just the steps that I have to take to get where I want to be. It's just gonna have to be really unfortunate for a little while, and then it will be okay.

Amanda believed and had been told by a teacher that she was not inherently good at math. At times, this caused her to question whether or not she should become a scientist.

Through the mindset of ability as fixed, struggling in a course or with a concept seemed to mean to most participants that they were not able to be successful, and not that the coursework was necessarily designed to be difficult or that a lack of immediate competence did not mean that they could not develop this competence. Further, finding math coursework challenging was especially salient for some participants pursuing physics and CS. Math coursework was required, yet it was not the reason they had chosen to pursue their field of study. For some participants, math coursework was a prerequisite to their core coursework, and so struggling in this way made some feel like this was evidence they did not belong in physics or CS. Despite the fact that several participants described their mathematics ability as intuitive or that it "came easily" for them, the discourse of ability as fixed created challenges for some participants, since they believed that struggling with math meant they were not inherently good at math. Most participants had a fixed mindset about their mathematics abilities, and that affected how they viewed themselves as scientists.

STEM Knowledge as Disconnected/Separate from the Real World
Most participants described how scientists seemed disconnected from the real world. Benjamin, in particular, described a professor that reinforced math as disconnected from real-world experiences, which had initially dissuaded him from continuing his mathematics education at the graduate level. Similarly, Tamas explained why he chose mathematics, comparing it to engineering which he described as being unconcerned with the truth and only concerned about real world applications:

> In engineering, you don't care about the details. If something works, it works, and you are happy with it. Even though it -the reason why it works- is not complicated. Otherwise, we really don't care if you understand it or not. If it works, your job is done then. And if it doesn't, then of course you need to understand it. I mean, mathematics is completely different. The only thing we care about is to understand it and there is no final product.

For Tamas, this was part of the reason he was pursuing mathematics. He liked the idea of a career pursuing "truth," disconnected from the messiness of real-world applications. Many men and women participants made this distinction.

The ideal of the scientist, toiling away alone in the lab in pursuit of "Knowledge," was a barrier for some participants who wanted a real-world connection to their studies. Furthermore, most participants referenced feeling external or internal pressures to pursue a degree that would lead to a profitable career. As a result, this ideal of the mathematician and scientist as disconnected from the real world, working with abstract concepts, combined with a discourse that STEM academic career searches were competitive and difficult pushed some women participants to choose not to pursue advanced mathematics and pushed others to different fields within STEM, like engineering.

Seeing the possibilities of mathematics research could bridge the gap between research as disconnected from the real world and the relationship between research as something that could improve the real world. For some men and women participants, seeing the connection between the research they were doing and how it could be applied in the real world was the reason they chose to pursue STEM. Margaret explained how her exposure to research in high school influenced her decision to pursue computer science.

> In high school, I did research at [name removed] University the summer of my junior year and in my entire senior year. So, I worked in the physics department and studied the optical manipulations of carbon nanotubes. And that was pretty neat, and that was where I decided I didn't want to do bio or chem.

While some participants reported being interested in STEM because it was disconnected from reality, others were dissuaded from pursuing math specifically, because some of the participants felt like STEM did not have real world implications. That is why involvement in research as well as even just exposure to research, such as with Laci's exposure to research through visiting lecturers in secondary school, was important for participants to see how careers in STEM could be applied. As a result, seeing the real-world applications of their studies helped some participants, specifically women participants, to decide to pursue mathematics and physics studies.

Part of the reason that STEM studies are seen as disconnected from reality can be attributed to a view of knowledge as static and unchanging for undergraduate participants. Specifically, this was seen in the discourses of most of the participants in mathematics. Mathematics participants described feeling satisfied with how the mathematical knowledge gained did not change or that scientific problems would have one correct answer. Participants felt comfortable with science and mathematics because they perceived it to always have a right answer or a solution to a problem. For example, Shannon explained the satisfaction that came with her STEM coursework because there was a finite end as it contrasted with writing a paper which took a lot of time to draft and edit: "it takes me about three months to be even remotely okay with it [essay assignment]." Especially when contrasted with other fields of studies, such as humanities studies, the perception that STEM knowledge is unchanging was contrasted to the "real world" with constantly shifting narratives and truths. Math was perceived by some participants as disconnected from those whims, and therefore pure and representing "truth."

Perception that Science is Masculine and Scientists are Men

The perception of ability as fixed was reinforced by perceptions of STEM as a masculine field. CS major Diane described the innate nature of CS as masculine, and pushed back against the imbalance being an issue of discrimination:

> People freak out because there's "not enough women in STEM." Well, not as many women are interested in STEM as men. "Well, that has to be systemic oppression because there's no difference." Well, there are differences

> between men and women. There are plenty of men in fashion and design, but there's not nearly as many as women, because men by default are not as interested in this kind of thing. There's nothing wrong with men who are interested in more feminine things or women who are interested in more masculine things. But, just because there isn't an even 50/50 between every line, it's not systemic oppression, it's just how we are naturally as people.

Related to the idea of ability as fixed, the idea that men are naturally more interested in STEM reinforced perceptions of STEM not only as masculine but also envisioned the ideal scientist as a man. This perception reinforces the idea of ability as innate and fixed, which, in turn, reinforces perceptions of STEM as a masculine field. Even Margaret, who identified as a feminist and was able to clearly describe how she was discriminated against as a woman in STEM, had internalized differences between men and women as innate. She described herself as being like a man: "I truly believe that I think more, socially more like a man than a woman. Um, so I don't really understand like spending three hours picking out a dress. I would rather be solving an issue, you know things like that. So not very girl." Some women students received messages from their professors or fellow students that they were not good at visualizing in three dimensions or that "physics is harder for girls," suggesting that women do not have the same abilities as men. Some women students also received messages or believed that most women do not pursue STEM because they are not as interested in STEM, further reinforcing the notion that women do not belong in STEM and that STEM is inherently masculine.

While most women participants acknowledged differential treatment because of their gender, Diane resisted the idea that there was a systemic reason for discrimination, reinforcing this idea that differences are innate:

> It's not like I came in here expecting to be discriminated against, or people to think I'm stupid because I'm a woman. I mean, if someone thinks that I am, okay, that's their problem, they're the sexist here. And that's not for me to get upset and offended over.

In this description, she admits to being treated differently, but is reluctant to ascribe that to her gender. She explained further: "I meet very few women who are as interested in tech or engineering as I am. And it's not because they've been discouraged or because they're too stupid. It's simply because it's not something that interests them. It's just not a part of who they are." One might hypothesize that by internalizing her ability as innate, to suggest any differential treatment or performance might be a threat to her identity as a computer scientist. To admit that treatment was different might also call into question her identity as a STEM professional who moves away from gender norms to be successful in a "man's world." The discourse that STEM ability is inherently masculine and thus women are less "able" to do STEM was prevalent throughout the data collected.

Challenges

Some women and non-binary students described feeling like they had to conform to the expectations of what a scientist was, which challenged their identity and what it meant to be an individual. We called this stereotype threat based on the literature.

Stereotype threat is a social psychological phenomenon where the performance of stereotyped groups is inhibited when stereotypes about the group are highlighted in certain contexts (Steele & Aronson, 1995). Given the perceptions that STEM is a field for men and for the masculine, presented previously, women participants did describe how they separated gender from their identity as a scientist. Women participants recognized that characteristics deemed as "feminine" were not valued in STEM. Women participants were expected to conform to the masculine discourses prevalent in STEM and were also given messages that women were not capable of being a scientist or mathematician. For example, Meg described how a fear of being perceived as not being able to do STEM work impacted women in STEM: "I feel like a lot of girls take it a bit more seriously just because there are so few of us in there. So, it's kind of, I wouldn't say higher stakes, but it's definitely more important for us that we're there." Similarly, this led to women participating less in class, as evidenced by observed differences between men and women in how they answered instructor questions. CS major Meg explained:

> There's like a group of maybe 3 or 4 guys who sit in the front row who either, like, answer the questions or, like, ask a majority of the questions. But there's definitely, like, a few people throughout the whole class who will answer [. . .] if I'm 100 percent sure I'll answer. But um, I think I've answered like one or two [. . .] I'm not someone who likes to be in the spotlight too much. So I'd rather just sit back and quietly answer to myself. Either I got that right or I got it wrong.

Similarly, Amanda explained why she would not ask questions in certain classes for fear of reinforcing stereotypes that women could not do STEM work:

> But classes […] where I struggle, I'm hesitant to ask questions. Because I know that they already, okay, like, "she doesn't know what she's talking about, why is she wasting my time right now?" So I'm a lot less likely to ask questions in classes where I struggle. Which is the dumbest thing in the world, considering, if I'm struggling, obviously I need to ask questions. It makes no sense but here we are.

Fear of reinforcing stereotypes appeared to lead to increased stress for women participants, which Amanda described:

> They [men] take it a lot less seriously than I do, personally […] which may be best because I'm kind of, struggling or whatever, that might just be a "me" thing. […] I'll be like so stressed out about whatever it is or whatever assignment, and they'll be like "oh okay. I'm not really concerned about it. Which blows my mind.

Women participants described feelings of fear of being wrong and were reluctant to answer questions in class unless they were 100% sure of their answers. The idea that knowledge in math and science is static and unchanging placed pressure on woman participants in particular to do well and avoid taking risks so that others did not perceive failure as further proof they could not do STEM work. These fears were only expressed by women participants.

Altogether, women participants expressed that they needed to create an identity that was smart, but not too smart, or that they had to work harder than their masculine peers to prove that they deserved to study STEM. Margaret explained how she needed to balance being smart, but not too smart in her CS class: "you, don't wanna be like, obnoxious. You know, you want to be respected. You want to earn your place. You don't want to be showy about it." By holding herself back, Margaret believed she would be able to gain the respect of her peers, even if she felt confident in her expertise. Margaret described her fear of becoming a "know it all by comparing her high school and college experience in CS:"

> My computer class was 12 people last year. And you know, she [high school CS teacher] like, she is so funny, and I love her to death, and she'll, you have to be very careful with syntax. If you misspell something, the entire program crashes. And so, he [college CS professr] forgot like an "L" or something. And in our class, she encouraged us to correct her, because you know, it will keep class flowing. And so I like shout, and I said something, like "oh you forgot an L." And I, immediately, I was like "Ohh, I'm that person." And actually, someone else behind me said something like 10 seconds after me about correcting something else. So, like, it wasn't just me. So, it made me feel better. But, um, so I'm sure somebody else who had taken Java, was just like, cringing on the inside just like I was. But no, it was embarrassing. You don't want to be the know it all.

Margaret described feeling disempowered because she could not be herself in her classes: "It is kind of disempowering because I'm having to be someone that I'm not. In the sense that like, I'm always the person who speaks up for others. And, not being able to speak up for myself has been weird." Margaret felt that her individual personality was unwelcomed in her STEM classes and therefore felt disempowered or like she could not speak up for herself.

Furthermore, women and non-binary participants described feeling challenged by gender norms and wanting just to be perceived as a scientist, not a woman scientist. Most saliently, non-binary physics major Shannon explained:

> I want to be thought of as a scientist first. And like, any of the issues that I have gender wise, like if I were to put a specific label, based off of like labels that people in the community have come up with, um, for genderqueer identities, I would probably say "Agender". Which would be like a lack of really any gender connection. And it's just like, to me […] I do have types of dysphoria. Like I have dysphoria over voice and my hips and general appearance things. But it's not really because I'm like "that's not what I look like." But it's more that key things that are identifying me as, like, specifically female. […] I don't want people having that cue, I guess. I want people to just treat me as a scientist. And that's, like, I think maybe because I've been getting more into the research, like properly more into my major, that I've

> like kind of come to […] at least I've settled for now to where it's just, like, I just want to be physics. I just want to be known for that, and that alone.

Shannon's explanation of how they wanted to be seen as a genderless scientist instead of as a woman or a woman scientist demonstrates how the notion of an ideal scientist as a man created challenges for them. As Shannon negotiated their gender identity, this notion of an ideal scientist created additional challenges as they sought to achieve an ideal that had been presented as disembodied and unencumbered when, in reality, it was created against a masculine gendered norm.

DISCUSSION

In this study, we set out to describe the ideal scientist by identifying the discourses that coordinate some of the work of becoming a scientist or mathematician. We applied the lens of gendered organizations in such a way to better understand if and how the discourses and processes that coordinate the student participants STEM work continue to create challenges for women (Acker, 1990; Harding, 2009; Smith, 2000). The findings from this empirical research suggest that participants used their K-12 experiences, their higher education experiences, and exposure to scientists to find meaning in what it meant to be a scientist. These experiences are important to understand because they provide a view into some of the early influences for the research participants on how a scientist looks, behaves, and feels.

Most salient for these participants are the discourses surrounding STEM ability as fixed, knowledge as disconnected/separate from the "real world," and STEM as masculine/"for men" (See Table 2).

Specifically, participants describe their reasons for pursuing STEM study because they found mathematics and science easy and enjoyable. Feeling like they were inherently good at math drove many participants to pursue an undergraduate or graduate degree in a STEM discipline that was math-heavy. Also, finding something difficult that others found easy became a part of their expectations for how they would find their higher education coursework. However, the mindset that ability is fixed did appear to create challenges for all participants when they encountered challenges in their coursework. Despite the fact that several participants described their mathematics ability as intuitive, that it "came easily" for them, the discourse of ability as fixed appears to create challenges for many participants, since they believed that struggling with math meant they were not inherently good at math.

Table 2: *Core Discourses that contribute to the notion of the "ideal" scientist*

Discourses	Quote	Related Challenges
Independence	He doesn't want to know what your neighbor knows. He wants to know what you know and what you are capable of, which is fair (Amanda).	Afraid to confirm stereotypes by asking for help
Ability as fixed	And, some people can do it, for them it's interesting because they can do it and it's the same question. And those people that cannot do it, it's not interesting because they cannot do it (Tamas).	Failure as evidence that one cannot develop competence
Scientific knowledge as "disconnected" from the real world	One of my professors here, he said he is not very interested in the application of things, like how things go. But he's more interested in the structure and connection between the two different structures in math . . . I'm, I'm not this guy, just doing things for the intent and purpose of doing it. (Benjamin)	Unclear about relationship between STEM fields and the real world
STEM as masculine	People freak out because there's "not enough women in STEM." Well, not as many women are interested in STEM as men. "Well that has to be systemic oppression because there's no difference." Well, there are differences between men and women. There are plenty of men in fashion and design, but there's not nearly as many as women, because men by default are not as interested in this kind of thing. There's nothing wrong with men who are interested in more feminine things or women who are interested in more masculine things. But, just because there isn't an even 50/50 between every line, it's not systemic oppression, it's just how we are naturally as people (Diane).	Stereotype threat

The perception of ability as fixed is reinforced by perceptions of STEM as a masculine-only field. Related to the idea of ability as fixed, the idea that men are just naturally more interested in STEM reinforced perceptions of STEM not just as masculine but envisions the ideal scientist as a man. Even Margaret, who identifies as a feminist and is able to clearly describe how she is discriminated against as a woman in STEM, internalized differences between men and women as innate. This was, in part, due to her perception of women students receiving messages from their professors or fellow students that they were not good at visualizing in three dimensions or that "physics is harder for girls." These received messages suggest that women internalize the perception of not having the same abilities as men, who are considered ideal for doing mathematics or science. Finally, women students are told and learn to believe that most women do not pursue STEM because they are not as interested in STEM. Altogether, these various messages and beliefs reinforce perceptions that most women do not belong in STEM and that STEM is inherently masculine.

Across this field of study, the research participants described the ideal scientist as a man, disconnected from the "real world" and that they were natural geniuses. These perceptions appear to be reinforced in society as well as within undergraduate and graduate programs. These discourses create challenges for women participants by creating the impression that they cannot succeed. That is, many participants are told that they will not be able to do STEM work. Stereotype threat and a reduced sense that one can be successful are also important influences on women in STEM higher education.

Similar to prior research (Parson & Ozaki, 2017), the expectations created by the practice of such discourses supports the recreating of a masculine ideal. Such an ideal contributes to a decreased sense of belonging or a perception that women's identities are incompatible with STEM (Ahlqvist et al., 2013; Good et al., 2017; Sallee, 2014; Griffin et al., 2015; Parson & Ozaki, 2017). Specifically, women participants described challenges meeting the ideal STEM scientist expectations. Women participants often felt that they had to present themselves in a way that was likable in order to be respected in their field. Specifically, participants described an unwillingness to speak up for themselves, rejecting behaviors expected of their perceived gender identity, and changing their personality to feel respected by their peers. Likewise, a feeling that one's gender is incompatible with a STEM career may have negative effects on STEM engagement and performance, pushing women towards opting out of science. Ahlqvist et al. (2013) in particular found that women who were more perceptive of gender threat were more vulnerable to the negative effects of the threat, which ultimately impacted their performance and persistence in STEM. Additionally, beliefs about STEM ability as innate are reinforced when people within a field hold a fixed mindset about intelligence and ability (Canning et al., 2019; Leslie et al., 2015). This fixed mindset can have major implications for academic achievement and persistence of women and underrepresented minority students in STEM, as evidenced by larger achievement gaps in the classrooms of faculty who believe ability is fixed and the relationship between ability as fixed and gender ratios in fields where brilliance is expected to be a defining characteristic of the field (Canning et al., 2019; Leslie et al., 2015).

These research findings reinforce research to date on the impact of stereotype threat on a woman's perceptions of STEM ability and self-efficacy. Women who are more sensitive to stereotype threat are more likely to be impacted by gender-mathematics stereotypes (Franceschini et al., 2014). When women participants, like those in this study, receive messages during their undergraduate and graduate school careers that their gender identity is incompatible with STEM, these messages can create challenges for them to persist in STEM.

CONCLUSION

Discourses and its practices communicate to higher education students an ideal for how a scientist should look, behave, and think. Those discourses and practices are guided, in part, by dominant discourses that marginalize the feminine and non-binary genders in STEM fields of higher education. Our goal with this research is to first construct this view of an ideal scientist and, then to deconstruct this ideal in order to understand if and how this view of an ideal scientist creates challenges for women and non-binary individuals in STEM. Undergraduate and graduate education is the primary location where students learn the culture, values, attitudes, and expectations of their academic discipline (Austin, 2002; De Welde & Laursen, 2011; Sallee, 2014). Negative experiences during undergraduate and graduate school can communicate to a student that they cannot be successful, and thus can impact how they view themselves as a STEM student and professional in the field (Bodnar et al., 2020). This impact can be exacerbated when the culture is biased towards masculine identity (Wong, 2015) as it is in the creation of this ideal scientist.

We recommend that STEM higher education faculty and administrators work together to counter these discourses and the associated practices. Examples of working together to counter these discourses can be seen in for example, the changes made at Harvey Mudd College (Alvarado et al., 2012). This research provides one step toward creating a greater understanding that informs the deconstruction and reconstruction of ideal STEM workers in higher education.

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