

Exploring the Historical Origin of Cultural Gatekeeping in Physics Education

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Culture in departments is rooted in history; by analyzing the historic culture of physics departments, we can better understand attitudes, assumptions, and ideas that permeate contemporary culture. We examine the evolution of the idea that physics education should serve as a filter, a practice commonly called gatekeeping. Physics graduate education saw great reform throughout the 20th century that developed many of the structures that are present today. In the present, our field is more diverse than ever before, and our current standards and expectations fail to support these learners. However, this failure is seen as the student's failure rather than the system's failure. This project analyzes arguments for and against calls to expand the field through 20th-century primary sources using a concept from social dominance theory called legitimizing myths and advocates for a reconsideration of the values that justify many of the arguments for the continuation of inequitable practices.

I. INTRODUCTION

The purpose of this paper is to call attention to the historical roots of certain lines of argument about departmental reform and inclusivity in physics graduate programs. While recent research has focused on the experience of minoritized members of our community and brought about a focus on the lack of representation of certain demographic groups [1–3], this is not entirely new information. Some physicists have been advocating for a more diverse field for decades [4–6]. Calls to address systemic barriers and workplace discrimination in physics programs have occurred since the beginning of the 20th century. However, while the social and political context that these calls for reform existed in is vastly different from our contemporary context, the arguments made against these proposals share similar underlying ideas and sentiments to modern arguments against departmental reform efforts to remove structural barriers that maintain the status quo.

This project originally started as a survey of historical sources to identify how physics graduate programs were designed in the United States. The goal was to better understand the purpose of various policies and structures in graduate programs that are often justified today due to their historical presence by considering the reasons provided when they were first implemented. In our search, the research team found a variety of sources that prompted the underlying questions: How do modern physics culture and assumptions about the field derive from the culture of the past? And, how does this culture impact policies and structures in physics graduate education?

When reading historical documents about issues such as the discrimination experienced by female scientists, we noticed how defenses of women’s low representation made half a century apart used the same arguments to justify the discrimination that women experienced as either necessary or the fault of those who were discriminated against [7,8]. To better understand these recurring arguments, this paper will analyze the culture of physics through social dominance theory (SDT). SDT originates from social psychology and describes how group-based social hierarchies are formed and maintained [9,10]. By considering the dominant perspective of physics departments, we can use concepts from SDT to analyze the factors that support and maintain these hierarchies. This paper will focus on one aspect of SDT known as legitimizing myths and show how these legitimizing myths connect modern arguments against removal of structural barriers and implementation of inclusive practices to past arguments, pointing out the shared assumptions that underlie these chronologically disconnected arguments.

II. DEFINITIONS

A. Legitimizing Myths

Legitimizing myths are a concept from SDT that seeks to explain how institutional discrimination is justified and normalized in society. These myths can either be hierarchy-attenuating or hierarchy-enhancing. Hierarchy-enhancing legitimizing myths (HE-LMs) “provide intellectual and moral justification for group-based oppression and inequality” [9]. Examples of HE-LMs include myths like the divine right of kings or phrenology. For example, the concept of divine right provides moral justification for a ruler to act as they want, because if they are chosen by a higher power, then clearly their actions are endorsed by that divine being and thus moral.

B. Gatekeeping

Hodari et al. wrote a collection of papers for the 2021 Proceedings of the US Community Study of the Future of Particle Physics (colloquially known as Snowmass) that address a variety of issues that perpetuate inequality in our field. In one of their papers, they define gatekeeping as “a set of behaviors, practices, and traditions, backed up by individual and organizational power to guard the boundaries of the discipline” [11]. In the practice of gatekeeping, even the most qualified members of our community are forced to justify their presence if they do not match the normative identity of a physicist. For example, Shirley Ann Jackson, a National Medal of Science recipient, and the first Black woman to graduate from MIT with a PhD in any field, described her experience with gatekeeping during her postdoctoral research at Fermi Lab: “The white males kept quizzing me on—one of them in particular—physics to see if I was smart enough to be at Fermilab” [12]. This experience is not uncommon for those whose identity is minoritized in the field. Many physicists have written about the way their identity impacts their interactions and the way their presence is policed in our spaces [11,13]. Rather than arguing for a removal or lowering of standards, our work criticizing gatekeeping advocates for reconsidering standards cognizant of how identity variably impacts aspects of education.

C. Culture

Culture is a difficult concept to define, and much work has been done to attempt to document the cultures of physics and STEM more broadly [11,14–17]. For this paper we will borrow a definition from Reinholz and Apkarian: “Culture is a historical and evolving set of structures and symbols and the resulting power relationships between people” [16]. The historical nature of culture is something this paper will explore. Concepts and assumptions that form the foundation of our modern culture are seen more clearly in the writings

of the past. Often departmental practices and requirements are justified due to their historical presence, but by analyzing the origins of many of these structures, we can better understand their purpose.

III. METHODOLOGY

For historical analysis, it is important to consider both primary and secondary sources. Primary sources are documents contemporaneous with the period we are studying, while secondary sources are writings by other historians about the period. Referencing both primary and secondary sources allows the consideration of unique historical examples that offer insight into our area of study, while also acknowledging the work done by others in this field [18]. The research team sought out sources that discussed program design, departmental culture, and issues of inclusion in physics. Primary sources were found by searching the American Institute of Physics (AIP) digital archive using relevant keywords. Examples of these keywords include labels of marginalized identities, such as women, Black, disabled, gay, and related terms, graduate training, qualifying exam (and synonyms like candidacy exam), and merit. Secondary sources were found through reading the work of science historians active in physics [19].

We considered documents from the beginning of the 20th century to the end of the 1980s. The beginning of the century was chosen as the start date because it has been identified as a period when American physics began a great period of reform [20,21]. The end date was chosen, as the research team felt it provided the historical distance necessary to evaluate ideas historically, which we felt was more difficult as we approached our current time. For example, one source comments on the lack of discrimination faced by women who pursue science [7]. However, since we know that this source comes from 1910, a period before women could vote in the United States, it is necessary to reevaluate the author's claims. This is less possible as sources become more modern, as there is less historical consensus and understanding of the culture.

Major changes in rights for minoritized identities occurred during the timeframe we are studying, both broadly and more specifically within physics. In 1920, women were granted the right to vote in the United States; in 1954, *Brown v. Board of Education of Topeka* mandated the desegregation of public education; in 1972, the American Physical Society created the Committee on the Status of Women in Physics, which advocated for women's place in the community; and it would not be until 1989 that Kimberlé Crenshaw introduced the legal framework of intersectionality, which considered the way individuals with intersecting identities were uniquely impacted by discrimination. This timeline provides important context for considering the sources described throughout the paper, as it can help illustrate the general state of access various minoritized identities had. Additionally, as discussed later in the limitations, this

timeline helps explain why a majority of the sources considered discuss gender inequity in physics, and why there is a dearth of discussion about other identities or the intersection of identities. Legal protections for disabled and LGBTQ+ identifying Americans did not occur until after the 1980s cutoff. So, for example, when sources use the term women broadly, they are likely referring to White, cisgender, heterosexual, able-bodied women. This limits our ability to speak to the perceptions of multiply-minoritized identities within these historical sources.

IV. HISTORICAL CONTEXT

A. Initial Poor Reputation and Reform of American Physics

At the start of the twentieth century, physics in the United States had a poor reputation internationally [20,21]. The founder of the American Physical Society, Arthur Webster, acknowledged that the United States' contribution to the physics community had been "painfully small" [22]. In *The Physicists*, a history of American physics throughout the 20th century, Kevles notes that a knowledgeable scientist remarked of American physics that "not a great deal of first class work is done" [20 pg. 76]. Many American physics students chose to complete their graduate work abroad at European universities as few American colleges had quality graduate preparation. Even if they did not complete their degrees in Europe, many saw spending at least some time in Europe as "essential" [20 pg. 39].

Gradually, American physics departments began to improve due to a variety of factors, such as an increase in student population, an increase in available funding and funded positions, and policy reform, such as making a PhD a requirement for faculty positions and making research an emphasis for tenure and promotion [20,21]. By the 1930s, American physics had dramatically improved its output and "closed the historic gap in quality" between itself and Europe [20 pg. 219, 21]. Kevles attributes this growth to two major factors: an increase in the number of physicists and the structured hierarchy that began to form around influential researchers and their departments.

B. An Aristocracy of Merit

Kevles calls the hierarchy that forms around physics and its institutions in this time an "aristocracy of merit" that is "democratic in its opportunities" [20 pg. 198-199]. We argue that this characterization of the system as a meritocracy is fundamentally flawed and can help us see the HE-LMs that influence how we conceptualize physics and our community. While some reforms to university policies moved the system towards more of a meritocracy, like the increased power faculty had in appointments and promotions [20], these reforms did not address the most fundamental issue of why physics in this period could not be meritocratic: the systemic discrimination present at this time.

Kevles later discusses the story of Jane Dewey, a White, female physicist who, in 1929, was rejected from a position because members of the department “simply refused to have a woman on the staff” [20 pg. 207]. Dewey’s experience is far from the exception; around this time, the committee of the American Association of University Professors “soberly concluded that, compared to males of similar quality, female academics were generally paid less, promoted more slowly, and treated with a ‘considerable degree of discrimination’” [20 pg. 207]. Despite acknowledging the discrimination faced by women in the field at the time, Kevles still refers to the field as a meritocracy. A system where qualified physicists are denied opportunities because of their identity is not aligned with this conception, and this disconnect highlights how ingrained the conception of our field as meritocratic is in our understanding of physics culture.

V. ANALYZING LEGITIMIZING MYTHS

A. Meritocracy

The concept of physics as a meritocracy is a HE-LM. Arguing that physics is a system where those who succeed do so because of their merit, implies that those who fail do so because they lack merit. However, there is ample evidence that many students who struggle to find success professionally or academically in physics do so because of discrimination or systemic barriers that are dependent on their identity. This myth justifies the discrimination those physicists experienced by arguing that they encountered this discrimination not because of their identity but because they were not qualified. Consider again Dr. Jane Dewey, who could not find a position because other physicists did not want their department to employ a woman. Any system where a professor cannot find a position due to their identity is inherently non-meritocratic. Yet examples of the system failing these individuals did not affect the overall image of physics as a field being a meritocracy. When minoritized people in the field encounter situations like Dewey’s and are either forced out or leave due to the mental and physical toll of putting up with discrimination, their departure is justified due to their supposed lack of intellectual merit or unwillingness to work hard.

The central myth of meritocracy influences how members of the community react when minoritized physicists describe their experiences with discrimination. Rather than acknowledge the non-meritocratic nature of the system due to discrimination, many would rather deny that prejudice occurred. James Cattell, a professor interested in cataloging the scientists of America, remarked in 1910, after finding that few scientists were women, that “there does not appear to be any social prejudice against women engaging in scientific work,” and uses this to argue there is an “innate sexual disqualification” [7]. Rather than considering that the system of his time (in which women did not have the right to vote) might in some way discriminate against women

attempting to enter the field, he assumes that women are not present due to a lack of intellectual capacity that originates in a difference between genders.

In response to a letter published in *Physics Today* in 1967 by Tannie Stovall about the discrimination he faced as a Black male physicist [23], one reader responded that, in his experience working with two Black scientists, “in neither case did I notice signs of prejudice” [24]. The letter goes on to compare the discrimination experienced by Stovall to the discrimination the author received for “not playing bridge [a card game]” [24].

In response to an article in 1985 discussing the prevalence of physics anxiety in women [5], respondents opposed the notion that this anxiety was due to any factor other than an innate biological difference. One respondent asked, “Why do so many feminists persist in the face of such evidence to hold environmental influences responsible for the math-science anxiety so prevalent in females?” [8]. Another argued that the article’s implication that “less competent and responsible students have ‘rights’ that can lead to dictation of policies for the nation’s educational system” was distressing to him [8]. This respondent makes the same assumption that these students who have struggled under these systemic barriers are less competent and responsible. All these arguments invoke the conception that physics as a field is a meritocratic system to refute the evidence presented. Rather than acknowledge that bias potentially exists in physics communities, respondents argue that the discrimination simply did not occur. In other words, under the HE-LM of meritocracy, if discrimination occurred, it was not because of the victim’s identity but instead due to their lack of academic rigor or oversensitivity.

B. Gatekeeping

Another HE-LM present in physics communities is the perceived need to gatekeep physics from those deemed unfit. There are various justifications provided for gatekeeping, including protecting the sanctity of the degree and the field, maintaining the reputation and prestige of a department, and that keeping certain students out of physics is morally just. In *Women Scientists in America*, Margaret Rossiter describes how graduate programs refused to accommodate female students and their varying needs: “The nation’s graduate deans... in the 1950s were determined to uphold the value of the Ph.D., especially in a period of expansion, and did not wish to cheapen the degree by making it easy to get. They were convinced that a high dropout rate was a sign of high standards and were utterly opposed to such arrangements as part-time study or childcare as unbecoming of ‘serious’ students at prestigious institutions” [25]. Concepts like “the value of the degree” and “cheapening the degree,” as expressed in the prior quote, are both examples of the need to gatekeep being used as a legitimizing myth to justify not accommodating and discriminating against members of the

community. Rossiter then goes on to describe how, after these women failed due to the systemic hurdles placed in their way, their failure was used as justification for denying future female applicants [25]. This example shows the overlap between the legitimizing myth of gatekeeping and the previously discussed myth of meritocracy. After women were gatekept from the field, their failure was not seen as the fault of a biased system, but instead was viewed as a failure of their intellectual character.

In 1941, Nobel Laureate Robert Millikan provided a different argument for why it was important to restrict access to the field. Reflecting on his experience teaching, Millikan argued “the most kindly, the most humane, act that can be done to nine-tenths of the youth of the land is to steer them away from, not toward, these difficult, analytical, intellectual pursuits” [26]. Here Millikan presents a moral justification for gatekeeping people from entering the field. Rather than seeing the participation of some individuals as a threat to the field, Millikan argues that it is a threat to those people themselves, as they are (in his perspective) not smart enough to succeed in the field, and that physicists have an ethical obligation to exclude them. While the reasoning is different, it justifies the same behavior as the need to protect the field.

A structure that commonly functions as a gatekeeper in physics academia is graduate examinations [27,28]. The exams that exist in physics graduate programs can be broken into two broad categories: diagnostic exams and evaluative exams. Some form of evaluative exam (under various names, such as qualifying exam, candidacy exam, department exam, etc.) commonly serves as a key barrier between a student and their PhD candidacy. Despite the importance and emphasis that is placed on candidacy exams, based on their positioning in a student’s PhD career, there is little literature in physics or other subjects examining the goals or formats of these exams. However, what literature there is shows how both departments and students conceptualize these exams as gatekeeping barriers [27,28]. For example, recent research shows that engineering students see these exams as designed to weed out weak students [29]. This perception is not new; older sources similarly discuss qualifying exams as rites of passage and the most common cause of a student leaving a PhD program for academic reasons [30]. There have been calls to reform these exams in physics as early as 1964, with a letter written to *Physics Today*, where the author calls for a reexamination of qualifying exams, noting how these exams can range “from superficial to sadistic” [31]. For as long as these exams have existed, their difficult and exclusionary nature has been deemed acceptable, with these known barriers justified as being necessary to maintain quality standards and departmental reputation.

VI. LIMITATIONS

As a project primarily concerned with the analysis of primary source documents, one limitation of the study is that

our analysis predominantly references calls to expand the field for women. Our sample contains some discussion of race, but discussion of queer and disabled identities is non-existent as are discussions of the intersection of multiply-minoritized identities. The timeline discussed earlier can help explain why certain topics were not discussed within our sample. In the period studied, both queer and disabled Americans lacked legal protection from discrimination based on their identity. Concern over the discrimination these groups experienced would not spark discussion or reform until well after the period considered.

VII. TAKEAWAYS

As more research is done into evaluating the standard practices of our field, and as discussions begin surrounding change of our longstanding structures such as candidacy exams, it is important to remember the context in which these discussions exist. Physics as a field is guilty of thinking of itself as a community of “no culture,” where concerns about politics and equality are unfit to be discussed [17,32]. Many feel the objective nature of the laws of physics proves the objective nature of our community, but this is not reflected in the data. The conception of our field as meritocratic and the perceived need to gatekeep certain social groups from entering our field are legitimizing myths that justify the personal and institutional discrimination faced by members of our community.

When we discuss meritocracy as the goal of our field it is important to consider that this conception came about when our field was mostly homogenous, and that, in the present day, our field is more diverse than ever before. Lenses like “intersectionality” unveil the differential impact of multiply-minoritized identities [33], which our field is just beginning to explore [33–39]. This diversity of learners requires different tools and structures to support it than the population that came before. Thus, it is important to modernize our standards for the field rather than relying on a historical precedent that was established when few people could fairly participate in the field.

The discussion of meritocracy is aligned with recent work based around challenging deficit models of learning. Recent work, like that regarding student performance in physics classes [40], highlights an alternative model: The class deficit model. Contrasted by the student deficit model, the class deficit model seeks to root the origin of a student performing poorly in a class not with the student but in the course's structures [41]. This focus on how structures can negatively impact student performance reflects a direct challenge to the legitimizing myth that student performance is reflective of their merit. We argue for this structure deficit framework to be expanded to a department level, where analysis of students’ experiences in graduate programs is focused on how the structures impact different students.

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