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RESEARCH ARTICLE

Identities in/out of physics and the politics of recognition

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Abstract

Framed within intersectionality, this multiple case study explores women's participation in physics through the construct of physics identity and with a focus on recognition. The study is drawn upon an empirical life-history exploration of three women: a native to Northwestern Europe, late-career white woman and two immigrant women to Northwestern Europe, one is an undergraduate student of color, and the other, an early career Muslim woman. The data for this study were collected through multiple, semistructured, interviews in a period of 2 years, which were analyzed using a constant comparative method. Collectively, the three life-histories tell stories of otherness, persistence, hope, and failure and they elucidate the kinds of identities that are deemed "in-place" and "out-of-place" in physics. They showcase how the three women authored multiple identities that simply co-existed for them, while for others were seen as conflicting and caused misrecognition. The findings point to four main insights: (a) recognition is neither linear nor binary and it comes in many different forms that range from explicit encouragement to no opposition; (b) it is drawn upon various sources including ones in the early years of life: family, school teachers, university instructor, students, and social community; (c) it is culture-dependent and as such, it is influenced by factors on multiple levels, including cultural and gender

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stereotypes, organizational policies, racism, sexism, classicism, and other forms of discrimination. The implications of these findings speak to the need for: (a) systemic programs on how women are recognized by others and which seek to widen and diversify physics environments from the school level to the professional level; (b) research exploration of the politics of recognition and how they perpetuate the underrepresentation of women in physics; and, (c) disrupting monolithic theorizations of recognition and adopting intersectional approaches to exploring physics identity that value women's personal histories, subjectivities, and positionalities.

KEYWORDS

feminism, gender/equity, women's issues

1 | INTRODUCTION

In every region of the world, women researchers remain underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields (Organization for Economic Co-operation and Development, 2019; Unesco, 2018). Interestingly, large-scale empirical studies point to the fact that this is not an issue of lack of interest or capability (Spelke, 2005; Stoet & Geary, 2018). More evidence of the fact that non-participation does not equal a lack of competence has been drawn from another set of studies to reveal how women's non-engagement in science is solely due to structural barriers including racism and sexism as well as social stereotypes and cultural expectations (e.g., Archer et al., 2020; Avraamidou, 2020b; Nasir et al., 2017). The study reported in this article focuses on physics because it remains a mainly male-dominated field where women are the least represented (Unesco, 2018). Global statistics show that the percentage of women in post-graduate physics positions is just below 20% while the highest drop in women's representation occurs between high school and university (Unesco, 2018). The underrepresentation of women in physics is problematic both from an equity perspective as well as talent utilization.

The underrepresentation of women in physics is a complex and problematic issue that relates to study choice, recruitment, as well as retention (Carlone & Johnson, 2007; Ong et al., 2018). The issue of gender disparity in physics becomes even more problematic when it comes to women who belong to minority groups, such as women of color, ethnic and religious minorities (Avraamidou, 2020b; Johnson, 2012; Ong, 2005). Detailed statistics on ethnic minorities in European physics, which defines the context of the study reported in this article, are scarce and difficult to extrapolate due to laws regarding the use of private data (i.e., EU-General Data Protection Regulation) as well as the diversity of colonization and migration histories of cultures across Europe. However, general global statistics show that Black, migrant, and ethnic minority women are severely underrepresented in physics (Network on Ethnicity and Women Scientists, 2007).

Essentially what this reveals is how a population of women exists that is almost completely absent from physics. From a research perspective, this raises several interrelated questions about the reasons why women are underrepresented in physics. What barriers, obstacles, and forms of discrimination do women encounter throughout their lives that might not allow them to enter or stay in physics? What do the lived experiences of those women who persisted and made their ways into physics look like? What types of identity negotiations are women in physics confronted with? How do different kinds of identity intersections support or hinder women's recognition as physicists? These are precisely the questions that I aim to explore in this multiple case study. In doing so, I aim to provide a unique contribution to the emerging knowledge base of the role of recognition in shaping women's (non)participation in physics. In this article, I draw upon an empirical life history, multiple case study of three women in physics: a native to Northwestern Europe, late-career white woman, and two immigrant women to Northwestern Europe. One is an undergraduate student of color and the other is an early career Muslim woman. In comparing and contrasting these three life histories I aim to examine how the three women experienced recognition throughout their journeys in physics and how different identity intersections shaped recognition across time and place.

2 | THEORETICAL UNDERPINNINGS

2.1 | Science identity

Quite a few researchers in science education have engaged with the construct of "science identity" in the past decade to explore students' engagement with science (e.g., Calabrese Barton et al., 2013; Varelas, 2012) and examined STEM study choices and careers (e.g., Avraamidou, 2014; Godwin et al., 2016; Kim et al., 2018; Vincent-Ruz & Schunn, 2018). A subset of these studies provided evidence of structural inequalities, sexism, and racism in science (e.g., Brown et al., 2016; Johnson, 2012; Wade-Jaimes & Schwartz, 2019). Another set of studies used identity as a lens to examine science teacher learning and development and highlighted the role of personal histories, race, gender, agency, and positionality and emotions in the formation of science teacher identity (e.g., Avraamidou, 2016; Moore, 2016; Moore Mensah, 2019; Rivera Maulucci, 2013). Identity has not only been used to frame studies with students and teachers but also with scientists. Several studies have used identity to examine the trajectories of women in science. The outcomes of these studies provide evidence of how social structures such as gender, race and ethnicity, and social class serve as barriers to women's trajectories in science careers (Johnson, 2012; Johnson et al., 2011; Ong et al., 2018).

Despite the different ways in which it has been conceptualized and used in science education research, the knowledge base provides evidence that the construct of science identity is greatly important, especially when studying individuals' engagement with science. As research shows, science identity offers itself as both a lens and a tool for examining how various cognitive and affective experiences influence how individuals see themselves and are recognized by others as science persons (Carlone & Johnson, 2007). This interplay between self-view and recognition points to the dialectical relationship between the self and the environment, which is inextricably bounded to sociopolitical realities and issues related to access, privilege, resources as well as to sexism, racism, and exclusion (e.g., Archer et al., 2020; Avraamidou, 2020a; Brown et al., 2016; Carlton Parsons, 2014; Wade-Jaimes et al., 2021).

Gee (2000) defined identity as being recognized as a “certain kind of person in a given context” (p. 99). Building upon this conceptualization and rooted within their ethnographic work with women scientists, Carlone and Johnson (2007) proposed a model of science identity consisting of three components: competence, performance, and recognition. Competence refers to knowledge and understanding of science content, performance refers to social performances of relevant scientific practices and recognition refers to recognizing oneself and being recognized by others as a science person.

Recognition serves at the heart of the account of this study while competence and performance are not explored. However, the selection of the three participants was based on a criterion of exhibiting strong competence and performance in physics, as evidenced both in their self-views as well their studies and career trajectories (i.e., high grades throughout schooling and graduate studies, engagement in scientific practices, etc.). In this study, I aim to examine the role of recognition in the formation of physics-identity, as a discipline-specific identity. Forming a discipline-specific identity deserves further attention because of the unique cultural characteristics of physics in comparison to other scientific fields, namely being the most male-dominated and the least ethnically and religiously diverse STEM field (Gonsalves & Danielsson, 2020).

2.2 | Recognition

Recognition has featured centrally in science identity research as a key component of identity and has been used to examine how one is recognized by perceived experts in science (Carlone & Johnson, 2007) or how competence and performance is perceived (Calabrese Barton et al. (2013)—meaning, how one’s identity is accepted or rejected by others. However, there is always tension between an individual’s science identity work and how it is accepted or rejected by others, which is particularly true for minorities in science, as for example, girls of color (Hughes et al., 2021).

Tracing the construct of recognition as well as theories of recognition leads back to Hegel’s *Phenomenology of Spirit* (1807) which presents the state or structure of mutual recognition as the structure of “spirit”: *I that is we, and the we that is I*, which is used to refer to the recognitive and social structures of human life. What this showcases is that our subjectivities are dependent on relations with others (Butler, 1993). Since then, contemporary philosophers, theorists, and researchers have taken up the construct of recognition to examine the struggle for an affirmation of particular identities (i.e., ethnic and religious minorities, gays and lesbians, people of color), typically labeled “identity politics” or “politics of difference.” As such, recognition found its place in studies on social justice, multiculturalism, feminism, race, and queer theories. As a construct, (equal) recognition is of paramount importance because it is inextricably bound to cultural, social, and political factors:

Equal recognition is not just the appropriate model for a healthy democratic society. Its refusal can inflict damage on those who are denied it ... the project of an inferior or demeaning image on another can distort and oppress, to the extent that the image is internalized (Taylor, 1992, p. 36).

While some theorists argued that recognition is not a utopian ideal but a necessary function of social relations (Honneth, 1996), others argued that the very concept of recognition might

supplant the central problem of injustice and represents the symptom of oppression (Oliver, 2015). Gimmler (2018), argued that “the concept of recognition might be allied with precisely those political and social realities that it wishes to criticize” (p. 317) instead of identifying injustice. As Oliver (2015) argued, recognition, much like vulnerability is distributed according to social and political power which is part of systems of dominance and oppression: some are provided recognition while others are made vulnerable through lack of recognition or misrecognition. Hence, the problem is that:

Not only does recognition by the dominant group reinforce the power structure of dominance insofar as those in power control who is recognized and who is not, but also recognition so conferred is part and parcel of a pathology of recognition inherent in colonization and oppression (p. 477).

Recognition is especially important in this study because it explores the lived experiences of three women, two of which belonging to minority groups with a distinct social positioning and unique identity intersections which made them vulnerable in the context of physics. While a few researchers have examined recognition of women in science in general and in physics in particular, an understanding of recognition remains at a superficial level addressing mostly the question of whether it is either conferred or withheld and where it is coming from. Such a binary approach to recognition as well as the absence of efforts to problematize and challenge the very conceptualization of recognition in science education is problematic because it leaves open the possibility of women in physics seeking recognition from the very people and institutions that are responsible for their underrepresentation. By turning a blind eye to this possibility, we are essentially ignoring the politicized nature of recognition. Hence, in this study, I aim to explore how recognition tights to issues related to sexism, power, racism, and Islamophobia. Such an exploration promises to shed light on the complexity and politicized nature of recognition and how it shapes women's (non)participation in physics.

2.3 | Intersectionality

For this study, I adopt intersectionality as a theoretical framework and I aim to examine how physics identity intersects with race, gender, social class, religion, and ethnic/cultural identity. Historically, *intersectional feminism* is situated in the 1960s and Audrey Lorde's writing, which centered her experiences as a Black lesbian, serving as one of the most important contributions of Black feminism and activism. *Intersectionality* is a term coined by Kimberlé Crenshaw in 1989 to counter the disembodiment of Black women from Law (Crenshaw, 1989). It was employed to reveal the inadequacies of legal frameworks in the United States to address structural inequality and discrimination resulting from the ways race and gender intersected to shape the experiences of Black employed women. In doing so, she used three dimensions to characterize intersectionality: (a) *structural intersectionality* which refers to multiple forms of structural oppression, such as racism, sexism, and classism; (b) *political intersectionality* which refers to politicized contexts and political agendas; and, (c) *representational intersectionality* which refers to how Black women's lives are situated in public discourses and embedded within racist and sexist stereotypes (Haynes et al., 2020).

Since then, numerous paths have led to various interdisciplinary intersectional studies in areas beyond legislative contexts such as education (Ladson-Billings, 1998; Naples, 2009), social

theory (Collins, 2019), LGBTQI studies (Bowleg, 2008), feminist studies (Davis, 2008) and postcolonial studies (Calás et al., 2013). As a heuristic, intersectionality is broadly defined as encompassing various complex and shifting interactions of social-identity formations where multiple identities co-exist (Davis, 2008). For this study, I build on Collins and Bilge's (2016) argument about the importance of analyzing the politics of identity through an intersectional lens as a way of addressing the complexity of overlapping qualities of power, social relationships, contexts, and inequality.

Hence, I stand with other researchers who adopted an intersectional theoretical lens to examine women's participation in science while paying attention to difference and diversity, such as ethnicity and class among women (e.g., Carlone & Johnson, 2007; Johnson et al., 2011; Ong, 2005; Rodriguez et al., 2017; Rosa & Moore-Mensah, 2016; Wade-Jaimes & Schwartz, 2019; Wilson & Kittleson, 2013). This requires a recognition that while similarities exist within the broader group of women physicists, each woman brings to the group different and distinct personal, cultural, and social histories, as well as resources to their lived experiences as physicists.

For this study, I use recognition, a key component of science identity, as the main theoretical construct and unit of analysis. I pay special attention to recognition because it offers a lens to understanding the kinds of identities that are allowed, supported, and recognized in different places and the kinds of identities that are considered unfitting and out-of-place (Avraamidou, 2020a). I adopt an intersectional approach as an overarching framework to explore how recognition was experienced by the three participants because I am interested in the structural, political, and representational issues connected to the underrepresentation of women in physics. By adopting an intersectional approach, I aim to examine how physics identity intersects with other identities (i.e., racial identity, gender identity, single motherhood, Islamic religious identity, social-class identity, and ethnic identity) and shapes women's recognition.

3 | EMPIRICAL UNDERPINNINGS

3.1 | Gender differences and gender performativity

A set of studies in science education provided evidence of the longstanding problem of women's under-representation in the sciences in general and physics in particular in the past two decades (Gonsalves & Danielsson, 2020). The findings of this body of work have been consistent throughout the years and indicate that women's under-representation in the sciences is not an issue of interest or ability (Francis, 2000; Hill et al., 2010). In a recent study with more than 10,000 students enrolled in an introductory physics course in the United States, Dew et al. (2021) found that performance and grades were weakly dependent on gender. On the contrary, research evidence shows that this underrepresentation is solely due to persisting gender-science stereotypes that exist across cultures as well as existing systemic barriers, such as sexism and racism (Avraamidou, 2020a; Bian et al., 2017; Miller et al., 2014). These are connected to both societal gender stereotypes and gender roles and the culture of science, which is constructed as hard and masculine (Francis et al., 2017; Harding, 1998) and essentially unwelcoming for women. The findings of a systematic review of empirical research (N = 47) carried out in the United States from 2006 to 2017 on the science experiences of female students during schooling, revealed how challenging it is for female students to identify with STEM

because their social environments communicate signals that women do not belong in the sciences (Kim et al., 2018). These findings are consistent with the existing knowledge base on women's underrepresentation in physics as well.

Several studies pointed to the impact of sociocognitive factors, such as “self-efficacy,” with female students reporting lower self-efficacy than male students in physics even if they perform better than them (Kalender et al., 2020; Marshman et al., 2018; Nissen, 2019). For example, in a study with 1400 students enrolled in an introductory physics course in the United States, Kalender et al. (2020) found self-efficacy differences between male and female students, and those differences showed a direct effect on learning outcomes. Similar findings were produced in a study carried out by Nehmeh and Kelly (2020) which analyzed the experiences of six undergraduate female students' leading to their choice of physics study in the context of an undergraduate physics program in the United States. The findings of the study revealed that the support of faculty, research opportunities, and peer socialization contributed to the development of the participants' self-determination, which was key to their persistence.

Another set of studies adopted a gender performativity lens (i.e., femininity–masculinity studies) to interpret gender to examine physics women's participation in physics (Archer et al., 2020; Gonsalves et al., 2016; Pettersson, 2011). The outcomes of these studies are consistent and point to the fact that physics is associated with masculinity and essentially legitimizing certain gender performances while excluding others. In ethnographic fieldwork, Pettersson (2011) examined the practices and discourses of a group of plasma physicists in a laboratory in the United States. Through observations and interviews, the researcher concluded that both practices and discourses about working at the lab were strongly associated with strength, physical effort, and masculinity. These practices and discourses were essentially used as marks of identity for the laboratory.

The association of physics with masculinity was also evidenced in a study with 15 students who studied advanced-level physics in England. Through a sociological analysis of 75 interviews of students tracked from 10 to 17, Archer et al. (2020) found that physics was strongly aligned with notions of intelligence and masculinity. This was directly related to students' reasoning for not continuing to study physics. Young men tended to express confident physics identities while the young women tended to express more precarious physics identities which were largely affected by popular representations of the “effortlessly clever” male physicist. Similar findings were produced in a study with 11 doctoral students (men and women) in a physics department in Canada (Gonsalves, 2014). The findings revealed that women were positioned as “Other” because of gender norms, while some women were found to be compromising their femininities and performing gender neutrality or “androgynous” performance to fit into the dominant culture of their department. This finding illustrates the problem of the construction of physics as a gender-neutral discipline that does not allow any forms of expression associated with femininity. Similarly, in a study with five women studying physics in Sweden, Danielsson (2012) examined how they negotiated their “doing of physics” and their “doing of gender” through an identity lens. The analysis of semistructured interviews with these women revealed that they all engaged in gender negotiations associated with both masculine and feminine forms. Specifically, the participants had to negotiate expectations about how a woman is supposed to be in a physics context, neat, diligent, following rules, and carrying out secretarial duties.

In contrast with these findings, Moshfeghyeganeh and Hazari's study (2021) revealed the absence of such gender identity conflicts and negotiations in Muslim majority countries where the representation of women in physics is high. With data collected through interviews with seven female physics faculty members in the United States who came from Muslim majority

countries, the researchers examined the participants' lived experiences focusing on how cultural experiences shaped their gender and physics identities. The analysis of the interviews revealed that expressions of femininity in Muslim majority countries can have a more constructive intersection with expressions of physics identity in ways that promote participation and persistence. This is attributed to various reasons such as, single-sex education, absence of cultural and gender science stereotypes associating physics with men than women, positive influences of religion in terms of motivation to understand the world as well as work ethic, as well as physics being associated with communal goals instead of competition which is connected to femininity. These contribute unique insights to our understanding of the cultural construction of femininity and problematizes the notion that femininity is incongruent with physics or at least not across contexts.

3.2 | Physics identity and recognition

In the past few years, we witness an increasing interest in identity-based research which has produced important insights into how men and women see themselves as physics persons and how they are recognized by others (Archer et al., 2015; Avraamidou, 2020b; Gonsalves & Danielsson, 2020; Hazari et al., 2007; Kalender et al., 2019). Identity offers a valuable lens to examining women's underrepresentation in physics as it provides us with the tools to examine the complex mixture of the personal, social, cultural, and political aspects of what it means to become a physicist and at the same time shed light on issues related to ethico-political values, power, and systems of oppression (Avraamidou, 2020a).

Similar to research examining cognitive factors and physics participation, identity-based research provides evidence of gender differences on how men and women see themselves as physics persons and how they are recognized by others. Kalender et al. (2019) examined physics identity alongside other motivational constructs of male and female students ($N = 559$) by administering a survey in introductory calculus-based physics courses at a large research university in the United States. The analysis of the surveys showed that female students reported significantly lower identity scores than male students. A related important finding was that receiving positive recognition by the course instructor as someone good at physics was particularly important for women and related to their sense of belonging and self-efficacy.

A review of the physics identity literature showcases the prominent role of recognition on identity development, study, and career choices. One example is the study carried out by Godwin et al. (2016), which aimed at understanding the impact of physics and mathematics identities on engineering choice. The outcomes of this study showed that recognition was found to be the most important component of identity in predicting a choice of a career in engineering (Godwin et al., 2016). Similarly, with data collected from 6772 college students in the United States, the researchers examined the correlation between physics and math identities with engineering study and career choice. The results showed that the recognition beliefs had the largest influence on students' math and physics identities. Similar findings were produced in a study carried out by Hazari et al. (2010) with data collected from 3829 university physics students' survey responses in the United States. The findings of the study showed recognition was the strongest component of physics identity. Second, a strong correlation between physics identity and physics career choice was revealed. Third, physics identity was found to correlate positively with a desire for an intrinsically fulfilling career and negatively with a desire for personal/family time and opportunities to work with others (p. 994).

Beyond the role of recognition of physics identity development and its impact on career choices, researchers studied how different types of recognition impact identity development. Wang and Hazari (2018) examined the impact of two types of recognizing strategies (explicit and implicit) on high-school students' perceived recognition and physics identity. Explicit recognition referred to teachers directly and explicitly acknowledging students' qualities and physics abilities. Indirect recognition referred to indirectly acknowledging qualities and abilities through assigning challenging tasks. With data collected through six longitudinal surveys over a year, researchers traced the physics identity development of 134 students. The findings of the study revealed that the synergy of the two types of recognition was crucial in supporting students' emotional engagement with physics and the development of their physics identity over time.

Besides the type of recognition, Hazari et al. (2017) also examined when female students become interested in physics careers. Through an analysis of data collected through a survey ($n > 900$), the researchers found that the highest percentage of participants became interested in physics careers during high school, and sources of recognition included the following: self-recognition, a perceived recognition by others, and a perceived recognition of other students around them. Interestingly, the most important source of recognition appeared to be students' high-school teachers.

Collectively, the findings of these studies provide evidence of the crucial role of recognition on physics identity development and especially for women who are faced with gender identity negotiations and misrecognition throughout their trajectories in physics. These findings are of interest to this study for various reasons. First, the fact that recognition was found to be the strongest component of physics identity points to the importance of a more in-depth examination. Moreover, the fact that physics identity correlated negatively with a desire for personal/family time and opportunities for collaborations, suggests the role of gender performance, social stereotypes, and cultural expectations in shaping physics identity.

Inasmuch as important these findings are on better understanding why women remain underrepresented in physics, they do not shed light on the diversity that exists among women or how various other identity intersections beyond gender and physics might shape recognition, such as race, religion, ableism, and queerness. Such knowledge is found in studies that adopted intersectional approaches to examining physics participation.

3.3 | Intersectional approaches to examining women's (non) participation in physics

A wealth of policy reports and research studies have offered evidence throughout the last two decades of how individuals who belong in minority groups (e.g., Black women, women of color, ethnic minorities) have been traditionally excluded from physics and have experienced a lack of recognition (Hyater-Adams et al., 2019; Ong, 2005; Rosa & Moore-Mensah, 2016; Traxler et al., 2016). The findings of these studies are consistent and show that Black women and women of color have experienced a lack of recognition and have been excluded from physics due to structural and systemic barriers related to their racialized identities (Hyater-Adams et al., 2019; Ong, 2005; Rosa & Moore-Mensah, 2016; Traxler et al., 2016).

One such example is found in Rosa and Moore-Mensah's (2016) study which explored the life histories of six African American women in physics. The analysis of the interview data revealed specific commonalities in their experiences. The first one is that all participants felt

isolated in the academy, especially as members of study groups, in which they felt excluded. The second one is that they all participated in after-school or summer school programs where they were exposed to science environments at an early age. Lastly, all participants had opportunities to engage in summer research programs along with their academic training and to be members of a community of practice. Similar findings were produced in Hyater-Adams et al.'s study (Hyater-Adams et al., 2019) who examined through semi-structured interviews the factors that influence 11 Black physicists' (men and women) physics identities in the United States. The findings showed that all participants exemplified strong identification with physics and experienced struggles in performing their physics identities due to structural and systemic barriers related to their racialized identities. Another important finding of this study was that the men who participated in the study shared how they mostly experience positive recognition as individuals who could succeed in physics, this was not the case for women.

Despite the challenges that women of color face throughout their journeys in physics some persist and succeed in physics. In a study exploring the strategies for persistence and success, Ko and Kachchaf (2014) through a life-story approach of 22 women of color who studied physics or astronomy in the United States, found that even though these women experienced social isolation, they were not passive victims of their academic cultures. The outcomes of the study showed that these women explored multiple forms of agency which included eight key strategies: seeking an environment that enabled success, circumventing unsupportive advisors, combating isolation using peer networks, consciously demonstrating abilities to counteract doubt, finding safe spaces for their whole selves, getting out to stay in STEM, remembering their passion for science, and engaging in activism. What these findings reveal is the need for discipline-specific frameworks that pay attention to the intersection of race and gender to better understand how race impacts women's participation in physics and how women with racialized identities can be supported throughout their studies and careers in physics.

This is precisely what Hyater-Adams et al. (2018) have done through the development of an operational framework that demonstrates how race impacts the ways that people identify with the physics discipline by picking up differences in the experiences of Black and white physicists. The framework combines physics identity constructs and Nasir et al.'s (2017) model of racialized identity, which includes three different types of resources: relational, ideational, and material. The framework is drawn out of the findings of a study with 36 Black and white physicists, including undergraduate and graduate students, postdocs, and professional physicists. The analysis of the data revealed the following connections: (a) recognition and relational resource connections, often in discussions concerning a relationship with a person, such as a colleague, gave the participants some form of recognition; (b) relational resource and ideational resource connections, where participants discuss an idea that people they know hold about them; and, (c) connections between recognition and ideational resources, which commonly occur when participants negotiate their positioning within the physics field. The value of this framework, as the researchers rightly argued, is that it provides us with tools to simultaneously capture the narrative story of participants while identifying structural and systemic features that impact Black women's participation in physics.

As evidenced in this brief review of key studies that adopted intersectional approaches to examining women's participation in physics, these have predominantly focused on the experiences of Black women and women of color. This pinpoints a gap of knowledge when it comes to other types of identity intersections, such as ethnic identity, religious identity, social class, disability, sexual identity, and motherhood. A couple of studies aiming to address these types of identity intersections provide evidence of a different set of barriers that women in physics might

face. Using science identity as a unit of analysis, Avraamidou (2020b) explored the barriers, difficulties, and conflicts that a young Muslim woman, an immigrant in Western Europe confronted throughout her trajectory in physics and how her multiple identities intersected. The findings of the study illustrated that the participant was confronted with various barriers across her journey in physics with the intersection of religion and gender being the major barrier to her perceived recognition due to cultural expectations, socio-political factors, and negative stereotypes about religion and specifically Islam. Moreover, the participant's social class, religion, gender performance, and ethnic status positioned her as Other in various places throughout her trajectory in physics and consequently hindered her sense of belonging throughout her studies and career in physics.

One identity intersection that remains under-explored in physics identity research, in particular, is the one of racism and ableism, which speaks to how race, racism, dis/ability, and ableism interact and are built into institutions of education and related discourses and affect students of color with dis/abilities differently than white students with dis/abilities (Annamma et al., 2013). As Erevelles and Minear (2010) argued, “the omission of disability as a critical category in discussions of intersectionality has disastrous and sometimes deadly consequences for disabled people of color caught at the violent interstices of multiple differences” (p. 128).

Empirical evidence from studies in STEM points to the importance of paying attention to disability and how it might shape (non)participation in science (Traxler & Blue, 2020). For example, Renken et al. (2021) examined how the intersectionality of deaf and hard of hearing minority racial/ethnic high school students' identities related to their engagement with STEM activities in formal and informal settings in the United States. Through interview data collected from three purposefully selected students (i.e., African American male, a Latino male, and a biracial African American/white female) who participated in a summer STEM camp, the researchers documented strong evidence about the importance of paying attention to issues beyond competency, abilities and instructional design in STEM, namely the intersections of social contexts of students' identities. Equally important, as another set of studies revealed, is the training of teachers and university instructors to enact practices that address issues at the intersection of science and disability. For example, Boda (2019) in a study with prospective students in the context of a course on diversity found that while the participants were able to reflect on their pedagogical decisions in contexts that included students labeled with disabilities, their plans remained disciplinary focused. Moreover, disability was the least recognized and interpreted marker of difference, in comparison to emphasis on other forms of difference such as race, class, and gender.

These theoretical perspectives and empirical findings point to the need for understanding dis/ability as a political and social category instead of a biological category as well as the urgency of a research exploration of its intersection with other identities in general and race in particular in the context of physics, which remains unexplored.

3.4 | Gaps in the knowledge base and purpose of the study

In synthesizing the existing knowledge base on physics identity, it becomes clear that there exist several studies that used large-scale data sets to examine the role of recognition on physics identity development (e.g., Hazari et al., 2010; Wang & Hazari, 2018). Fewer studies have used qualitative interpretive methods to examine the role of recognition on physics identity formation as well as intersections between physics, gender, and race (e.g., Hyater-Adams et al., 2019).

Despite the usefulness of these studies in producing insights on how recognition shapes physics identity, missing remains an in-depth understanding of how the intersection of various other identities beyond race and gender support or hinder recognition. Missing also remains a less binary and more complex approach to examining recognition, which goes beyond its presence/absence and which also problematizes the construct itself.

This is precisely what I aim to do in this study. Hence, in carrying out this multiple-case study my goal is to complement the existing knowledge base on physics identity with a broader intersectional exploration of recognition across time and place, which goes beyond gender and race to include religious identity, social class identity, and motherhood. To achieve this goal, I explore how recognition looked for three women with distinct social positioning and identity intersections: (a) physics, gender, social class, and single motherhood; (b) physics, gender, social class, and race; and, (c) physics, gender, social class, ethnicity, and Islamic religious identity. In so doing I aim to respond to the following research questions:

1. In what ways have three women with distinct social positioning experienced recognition throughout their trajectories in physics?
2. What kinds of identity intersections supported or hindered each woman's recognition as a physicist?

In responding to these questions, I aspire to contribute to the existing knowledge base of physics identity studies through an exploration of the role of recognition on physics identity formation within various sociopolitical contexts, as well as how various identity intersections that remain underexplored might support or hinder women's participation in physics. Such an examination promises to shed light on the experiences of women in physics by offering an intersectional understanding of their physics identity trajectories across time and place. Attending to recognition through an intersectional approach affords us the lens to understand not only the personal but also the social, cultural, and political aspects of physics (non)participation associated with the question of who is allowed and valued in the world of physics and who is constructed as an outsider (Avraamidou & Schwartz, 2021). This is precisely the contribution of this study as it strives to elucidate the kinds of identities that are deemed "in-place" or "out-of-place" in physics.

4 | METHODS

4.1 | Narrative intersectionality

In carrying out this study I am interested in women's narratives that tell stories of *becoming* physics persons; essentially, stories of forming physics identities. These narratives are examined through a life-history, narrative-inquiry approach and they encapsulate how these women have come to see themselves as physics persons, how they have been recognized by others, what experiences served as resources to their journeys in physics, and what experiences served as borders and barriers to the formation of their physics identities. As Somers (1994) argued, "people construct identities by locating themselves or being located within a repertoire of embodied stories; that experience is constituted through narratives" (p. 614). Intersectionality is used as a lens to examining how recognition differed for each of these women because of their distinct social positioning and consequently different kinds of identity intersections. In using a narrative approach, I aimed to offer women a safe space where their voices and subjectivities can be

heard so they can tell their stories as physicists. In doing so, I aimed to capture the complexity and multiplicity of their lives, their unique identity intersections, and negotiations, as well as their desires, dilemmas, vulnerabilities, and humanities.

4.2 | Context

The data for this study were collected in a county in Northwestern Europe where I met the participants 4–5 years before the study. The country ranks among the highest in Europe in terms of economic freedom, human development, and quality of life. The country has a colonial history, however, it still has very little awareness of its colonial history and power, as historians and academics have persistently abstained from making those colonial connections (Wekker, 2016). Educational research has also abstained from seeking colonial connections and examining how those have shaped a currently colonized curriculum and apolitical educational research.

National statistics show that the native population decreased by 26,000 while the population with a migrant background increased by 304,000 people (CBS Annual report, 2018), which is representative of the current migration wave in Europe. The term “migrant background” refers to newcomers who migrate to the country, including displaced migrants seeking asylum, refugees and voluntary migrants. In 2018, the four major ethnic groups of migrant backgrounds in the country were Turkish, Moroccan, Surinamese, and Antillean. The majority of individuals belonging to these minority groups are employed as technical workers while some are asylum seekers. When it comes to religious minorities, there is a very small representation of Muslims (below 2.5% of the population), and the general perception natives have of Muslims and Islam is negative (Velasco Gonzalez et al., 2008).

4.3 | Participants

Table 1 provides an overview of the three purposefully selected participants (pseudonyms) in terms of their social positioning and identities alongside information about their studies and professional careers.

4.4 | Data collection and analysis

The data for this study were collected through semistructured, biographical interviews based on an interview protocol that was tested with 10 women working in STEM careers in the same country, as part of a larger study, and was revised multiple times (Avraamidou, 2020b). To achieve internal validity of the interview, different questions aiming at gaining the same kind of information were phrased in different ways and inserted at different places in the interview protocol.

Maxine and I had a two-hour-long interview which took place at her office space upon her request. The interview followed a few emails for clarification and elaboration on specific stories. Sahira and I had two 1-h interviews. The first one took place at my office and the other one at a café at the university. Following the interviews, we talked on the phone twice and exchanged two emails to elaborate on specific stories. Zehra and I had three interviews that varied from 30 min to 2 h. The first one took place at my home over dinner, the second one took place at her office and the third one at a café, upon her request.

TABLE 1 Participants

Name	Current occupation/place	Social positioning/ identities	Studies and professional career
Maxine	Physics instructor in higher education, native to Northwestern Europe	52 years old Single mother of two children Born and raised in Northwestern Europe White, native, upper-social class family	Schooling in Northwestern Europe Undergraduate and graduate studies in Northwestern Europe PhD in experimental physics and postdoctoral studies in nuclear astrophysics in the United States Research position at a lab for 10 years in Northwestern Europe Teaching position in Northwestern Europe (2010 till today)
Sahira	Physics undergraduate student, migrated from India to Northwestern Europe	19 years old Born and raised in India Working-class family Woman of color	Schooling in India Undergraduate studies in physics in the United States and Northwestern Europe (2017 till today)
Zehra	Physics instructor in higher education, migrated from Turkey to the United States to study and to Northwestern Europe to work	35 years old Born and raised in Turkey Working-class family Muslim	Schooling in Eastern Turkey Undergraduate studies in physics in Western Turkey and PhD and postdoc in experimental physics in the United States Teaching position in Northwestern Europe (2014 till today)

The interview protocol included three sets of questions. One set included biographical questions alongside others that targeted recognition by their families. The second set consisted of questions targeted at extrapolating information about participants' schooling and university experiences and recognition by teachers. The third group of questions applied only to Zehra and Maxine and aimed at collecting information about their physics career experiences and how they perceived recognition by their colleagues, students, and social communities.

For the analysis, I used a combined framework of science identity (Carlone & Johnson, 2007), intersectional analysis (Collins & Bilge, 2016), and grounded theory (Charmaz, 2014). Grounded theory refers to a set of systematic inductive methods for conducting qualitative research aimed toward theory development (Charmaz, 2014). To carry out the analysis, I adopted a combination of in-vivo and open coding techniques through a line-by-line analysis during three rounds of coding that resulted in an inductive construction of theoretical categories (Strauss & Corbin, 1990). More narrowly, the physics identity framework provided the structure to explore the role of recognition in physics identity development, and intersectionality provided a lens to explore the dimensions of intersectionality as well as the kinds of identity intersections and negotiations that supported or hindered recognition. The

three rounds of coding were as follows: (a) I coded the data for recognition; (b) I coded for identity intersections; and, (c) I coded for the three different dimensions of intersectionality.

Codes related to recognition included: (a) sources of recognition (e.g., father, mother, grandparents, siblings, social community); (b) type of recognition (e.g., explicit, implicit); (c) time/place where it occurred (e.g., childhood in India). Codes related to the dimensions of intersectionality included: structural (i.e., sexism, racism, classism); political (i.e., political agendas and contexts); and, representational (i.e., how women are situated in science discourses). Intersectionality also provided a lens to code the data in terms of the kinds of identity intersections and negotiations that participants faced throughout their trajectories in physics and which serve either as resources or barriers to their recognition. Examples of such intersections include: (a) gender, single motherhood, and physics identity; (b) gender, social class, and physics identity; (c) gender, social class, race, and physics; (d) gender, social class, Islamic religious identity, ethnicity and physics.

Adopting a grounded theory approach, I used an inductive, iterative approach to the analysis to discover patterns in the data and identify commonalities and differences in how the participants experienced recognition. Using a constant comparative method and through multiple rounds of axial coding with the use of Atlas.ti, two theoretical themes emerged: (a) experiencing (mis)recognition throughout trajectories in physics; and, (b) identity intersections across time and place. The first theme is meant to capture how the three women experienced recognition either actual or perceived, and the second is meant to capture the kinds of identity intersections and negotiations throughout their lives and in different places. Table 2 presents an example of a data analysis matrix.

4.5 | Limitations and trustworthiness

As a case study, the findings of this research exploration are limited due to its size as the findings are not generalizable in the conventional sense. By definition then the number of participants is small and idiosyncratic and hence, I cannot claim that these findings are generalizable beyond the participants of the study or applicable in other contexts. It is, however, likely that these three life histories represent the experiences of other women in physics, and the ways specific identity intersections support or hinder recognition are transferrable beyond the context of this study. Even though the participants were purposefully selected to present unique identity intersections, these intersections are not atypical in any way. Another limitation of the case study approach is connected to my closeness to the study as the sole researcher and my biases in interpreting the data, which I tried to minimize through the use of different methods.

In pursuit of a trustworthy study, I employed several strategies that correspond to four theoretical constructs proposed by Guba (1981): credibility, transferability, dependability, and confirmability. I adopted a life-history case-study approach, which is not only well-established but is also where my methodological expertise lies. I adopted purposeful sampling to maximize diversity among the participants, instead of aiming at generalizability, which fits with the goal of the study. In addition, I used triangulation strategies through the use of multiple interviews, iterative questioning as well as the use of multiple kinds of data (e.g., interviews, emails, phone calls) from the same participant at different points in time for the same purpose (Charmaz, 2014). Moreover, I had frequent debriefing sessions with the participants alongside member checks. All participants were provided with the opportunity to read, comment, and correct both my transcripts of their interviews and my assertions. In so doing, the findings are offered as a result of a combination of experiences and ideas of the participants and the negotiations between us, and not solely as my subjective interpretations.

TABLE 2 Data analysis

Intersectionality dimensions/ structural/political	Codes	Subcategory			Context	Theme		
		Source of recognition	Type of recognition	Impact of recognition		Experiencing recognition	Identity intersections	Extract/source
Maxine Structural	Sense of belonging Gender Active support Physics program environment Male-dominance	Female university teaching assistant	Explicit	Resource	University/ Country- context	Recognized as a woman in a male-dominated environment and received explicit support	Physics gender	Because of her presence, we did not feel completely out of place (interview #1) Everybody else was male. She was very adamant about women's participation in science and she actively supported us (interview #2)
Sahira Structural	Patriarchy STEM career as a path to financial freedom Science competency Support	Mother	Explicit	Resource	Schooling years/India	Recognized as a competent science person and was encouraged to study physics as a path to financial freedom	gender, physics and social class	She would often tell me: "You need to be financially independent when you grow up. I do not want you depending on men" (interview #1) She was like: "You are doing well in

(Continues)

TABLE 2 (Continued)

Intersectionality dimensions	Codes	Subcategory		Context	Theme	Theme	Extract/source
		Source of recognition	Type of recognition				
Representational/structural/political	Open and in-vivo						the sciences, you are a good student, keep it up". (interview #2)
	Zehra Political	Islam Hijab Government law Discrimination	Institution Implicit	Barrier	University/ Western Turkey	Experienced misrecognition connected to forbiddance of religious identity expression	Islamic religious identity Gender and physics

Triangulation strategies were also used to minimize my bias during the analysis process of the three data sets. This was done through the involvement of an external researcher who coded independently the data set of one of the participants using the coding scheme and which we then discussed and negotiated until reaching a final agreement. In the cases where there was no consensus, the disagreements were resolved through a member-check. Coding 1/3 instead of the standard 20% of the whole data set was deemed appropriate given the small number of participants. For transferability purposes, I provided thick descriptions of the three participants' life histories alongside information about the context of the study to allow comparisons and transfers to be made.

4.6 | Positionality

Similarly to Noblit et al. (2004), I acknowledge that I “exist within a critical discourse that in part makes me responsible for the world I am producing when I describe, interpret, and critique social phenomena” (p. 24). In this case, I hope that my interpretations focused on critiquing a range of social stereotypes, prejudices, and discriminatory acts entangled within sexism, racism and other forms of exclusion might contribute to addressing goals related to equity and social justice in physics. I bring to this study my life history as a woman in science alongside my distinct and intersecting identities at personal, social, and professional spheres: I identify as someone with a strong science identity, I come from a working-class, refugee family, I am a migrant to Northwestern Europe and I am professionally invested in promoting goals related to equity and social justice in science.

I work at the same institution where Maxine and Zehra work and Sahira studies. Maxine, Zehra, and I work at the faculty of sciences and we teach courses to physics students. The three of us had various opportunities to share our experiences as women in a faculty of science and to also serve as a network of support for each other before the conceptualization of this study. Like Zehra, I was born in the Mediterranean region, I studied in the United States, and I migrated to Northwestern Europe 4 years before this study. Zehra and I share cultural customs and we have formed a unique friendship over the past few years. Even though I am an atheist, I bring to this study understanding of what an Islamic identity might mean because I grew up in a country that provided ample opportunities to interact and form close relationships with Muslims. Sahira, on the other hand, is my former student and hence the distance between us is bigger. Sahira was a student in one of my classes that emphasized issues related to diversity and inclusion. This is precisely what connected us, given the experiences we both brought to the class due to our identities. Following the completion of the course, Sahira and I found ourselves in the same circle of friends and we frequently discussed issues related to our experiences, as women in science.

From the conceptualization throughout the completion of this study, I positioned myself as an insider to the study and I had built a dialectical relationship of care, respect, and trust with all three participants before I engaged in data collection. In fact, it was only after these relationships were formed that this study was conceptualized.

5 | FINDINGS

The findings are presented in a form of story-telling through the use of 3–4 stories for each participant that were perceived as critical to their journey in physics. These stories take place in different contexts and each of them serves to highlight how the participants experienced recognition throughout their trajectories in physics as well as the kinds of identity intersections that

supported or hindered their recognition as physicists. The stories presented are derived from a synthesis of various excerpts from the interview transcripts and they constitute the products of a step-by-step analytic process of narrative inquiry in search of meaning-making. This process of storying the transcripts was based on the following steps: holistic-content reading of interviews, chronologically plotting of the elements of the story, follow-up interviews as a way of collaborating and co-creating with the participants, and developing the story through structural analysis. This structural analysis was guided by the following questions: What is the context (time-place)? Who are the main characters? What are the main events or actions in the story? What are the outcomes? How has the participant positioned herself in the story? (Nasheeda et al., 2019).

5.1 | Maxine: Gender, social class, single motherhood, and physics identity intersections

The first story is situated within Maxine's family context and serves to illustrate the resources and recognition that she received as a member of an upper-class family with a tradition in science careers. The second story is situated in high school, where Maxine was explicitly recognized by her teachers as a competent physics learner. The third story takes place in a university where Maxine found herself being the only other female student in a cohort of 100 students. In this context, a female teaching assistant appeared to have played a critical role in Maxine's thinking about women in physics. The fourth story reflects Maxine's experiences as a woman in a physics research lab where she was challenged with multiple barriers as a single mother trying to meet her job's expectations.

Story 1: *It was geek-speak all over the place*

In my family, both my brothers are science types. My older brother studied physics and my younger brother studied aviation engineering. So, when I was home, it was geek-speak all over the place [laughter]. That was our normal. During the school vacation, we would go to my grandparents and then my grandmother would take us to school where we would get to look through a microscope and that sort of stuff ... My father would read these adventure books with girl protagonists as bedtime stories. It wasn't until I could read the books myself that I discovered how most of the time it was *the boys* who were going to the moon, etc. But, that wasn't the way that my father would read the story. He would just switch the gender!

This story reflects how Maxine's family environment was not only conducive to science but also encouraging active participation in science. Both of her brothers, older and younger, chose STEM-related studies and, at home, conversations tended to focus on science, which Maxine described as their normal. This reference to "normal" might imply enculturation into science through which Maxine not only developed an understanding of values, norms, and discourse of science but through which she also developed a sense of belongingness. In addition, Maxine had a wealth of experiences with science in out-of-school settings where opportunities to explore nature and to use scientific instruments and tools were offered. These events serve as proof of her rich capital in terms of science experiences during her childhood. At the same time, this story also points to her being recognized as a science person by her family, given that she was included both in conversations about science as well as in the science activities her brothers engaged in.

Perhaps more important than these events and experiences is Maxine's interaction with her father, which reflects his understanding of intersections of gender and science. Maxine's father

was a psychologist who was aware of and interested in gender roles and that is perhaps why when he read bedtime stories to her, he would switch the gender. As a result, in these bedtime stories, a female protagonist would always be an adventurous character who had a strong sense of agency and who had explorative and leadership roles. Beyond revealing the intersections between gender and science, this story also speaks on social-class identity. The role of social class is found in this story not only through access to resources and opportunities to actively participate in science but also through the influence of Maxine's father. As a highly educated person, her father had access to specific intellectual resources that drew him to the thought of switching gender roles in children's literature to diminish social gender stereotypes and to reconstruct the roles.

Story 2: *Physics, of course; you are so smart!*

When I had to figure out what I was going to do, I already knew I wanted to do physics. And, my physics teacher and math teachers were like *Physics, of course, you are so smart!* And then, we had one of those workshops where you had to do these tests to decide what would be a good career path, and I scored in the top zero percent of geekiness. Now, it was like *yeah, duh!*

In this story, situated in the context of high school, it becomes apparent that Maxine was perceived as a physics person. Implicit recognition of her as a competent physics learner was evident in the high scores on her tests. Explicit recognition in the form of acknowledging abilities and expressing expectations on study choice was evident in her interactions with her teachers. This recognition sealed Maxine's desire to study physics.

Story 3: *Everybody else was male*

When I started to study physics at university, we were a cohort of a hundred students and only two were female. We stuck together because of that. And, we both survived and had a small group of friends. We worked together under the only female teaching assistant. Because of her presence, we did not feel *completely* out of place. *Everybody* else was male, all my fellow students, all my instructors...It's kind of nice to realize that you're not the only one. That one female teaching assistant was way more of a radical feminist than I've ever been. She was very adamant about women's participation in science and she actively supported us.

This story, situated in the university context, reflects the intersection of gender and physics and it essentially highlights how male-dominated the field of physics is, hindering a sense of belonging for women. At the same time, this narrative serves as evidence of the critical impact one female teaching assistant had on supporting Maxine to not feel "completely out of place". It is equally relevant to mention how Maxine and the only other female student stuck together and "survived," as Maxine stated. This highlights both how getting through the program was perceived as an experience of survival and how surviving it would not have been possible without the presence of another female student. Moreover, the influence of a female teaching assistant on feeling less excluded in a male-dominated classroom appears to be of paramount importance. However, this went beyond gender. As a feminist, the teaching assistant was well aware of gender issues and discrimination in the sciences and so actively and intentionally supported Maxine. Beyond this narration, Maxine shared different stories with me in which this instructor engaged in conversations with the two female students both during tutorials and during office hours and breaks, essentially serving as a role model and a source of support for them. By adopting this role, the teaching instructor explicitly recognized Maxine as a competent physics person.

Story 4: *Everything and everyone is gender-biased*

I could not continue doing that work because it was just too stressful combined with single-parent life. I was sick and tired of the “publish and perish” atmosphere and the working 70 hours per week kind of expectation. Combining that with two little kids was just not working for me. For example, there were no policies in place to allow me to travel with my kids. Everything and everyone is gender-biased: the policies, the professors, the environment ... both implicit and explicit. Some women might say: Well I'm just going to tough it up, but I was like: *Screw this; I'm going to do something else. I don't want to be treated like this. I don't want to suffer like this.* I think it's in the culture of physics; this attitude that you're not a full physicist, if you're not working full-time, totally dedicated, ignoring your kids and being a physicist 150% of the time, and nothing else.

This story is situated in Maxine's most recent professional environment, as a leader of a research group in physics, which she quit 5 years ago to take up a teaching position at the same university. In this story, various issues become prevalent but perhaps the most important is that of the barriers of single motherhood. The current reality of academia, which includes unrealistic expectations in terms of research, administrative duties, traveling, and the culture of over-work in conjunction with gender biases and discrimination against women makes academia, and especially male-dominated fields such as physics, an unwelcoming space for single mothers. In Maxine's own words, this experience caused her suffering and the feeling that she had to strip off her maternal identity to perform her physics identity (Figure 1).

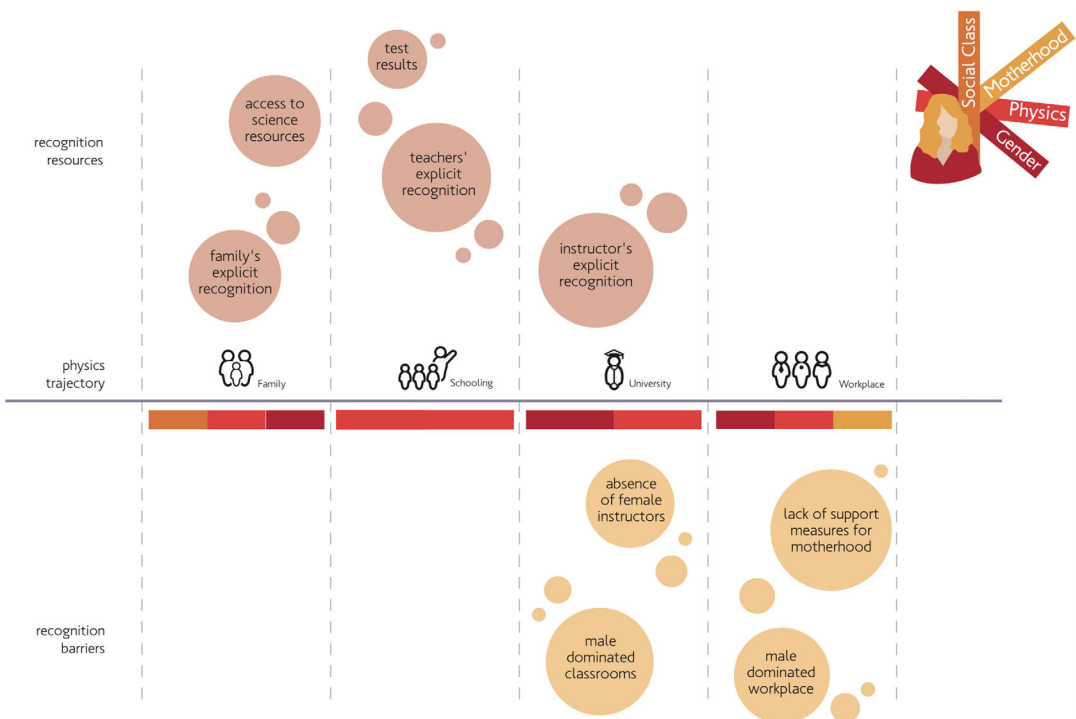


FIGURE 1 Maxine's physics trajectory

5.2 | Sahira: Gender, race, social class, and physics identity intersections

In what follows, I share five stories from Sahira's life story that stood out throughout her narration of how she decided to study physics. These stories take place in different sociopolitical contexts and illustrate how she was recognized (or not) as a woman of color in physics. The first four stories are situated in India and provide insights into Sahira's early life experiences in terms of her interest in physics. The first story illustrates how her father nurtured her interest in science. The second story sheds light on what being a working-class woman in the suburbia of India might mean. The third story provides evidence of explicit recognition of Sahira as a competent physics learner by a high-school teacher. The last story is situated in Northwestern Europe where Sahira currently studies physics. This brief story showcases Sahira's perceived recognition as a woman of color in a predominantly white and male-dominated undergraduate physics program.

Story 1: Tell me how this machine works

A lot of what I remember from my childhood is that we would keep going to Mumbai, to bookstores to buy books. My dad loved books. He had a lot of books and he would pose questions to me and my older brother: *Tell me why or how does this machine work?* We would then try to find answers using encyclopedias. My dad had to sail as part of his job, so he would spend a lot of time explaining to us how ships worked ... I think a lot of it started there. Otherwise, I don't think I would have thought of science that much ... we used to go to this big science museum where they had exhibits of interactive models about how things work, a lot of cool models that I could play with.

Quite a few things become prevalent in this story that are connected to Sahira's identity trajectory in physics. Firstly, as a child, she had opportunities to engage with science not only through visits to informal science institutions but also through family conversations. In the first interview I had with her, she shared how she would spend quite some time "building stuff" with her older brother and how they would engage in "science-y discussions" with their father. Moreover, the questions posed by Sahira's father also imply that she was implicitly at least recognized as someone capable of engaging with how/why kinds of questions. This story encapsulates Sahira's rich family capital in terms of providing opportunities to engage with science questions.

Story 2: I don't want you depending on men

My mom has a degree in education and she used to teach math and physics before she got married, after which she had to quit her job. She would often tell me: *You need to be financially independent when you grow up. I don't want you depending on men. Men will come and they will go; they will leave. And you know what happens when they leave.* So, when I said: *I want to do physics*, she was like: *Nice, you will be financially independent*, and she made sure I didn't slack. She was like: *You are doing well in the sciences, you are a good student, keep it up.*

This story serves to illustrate gender, social class, and cultural intersections, and how these might have influenced Sahira's decision to pursue higher education, especially in physics. As evidenced in this story, Sahira's mother had emphasized her desire for Sahira to be financially independent of men. The way to do that, especially for girls growing up in working-class families in rural areas in India was through higher education. This is especially relevant to the

sciences, which usually lead to higher-paid professional positions. At the same time, this story also provides evidence of how Sahira's mother not only supported her decision to study science but also explicitly recognized her as a competent science person.

Story 3: *I wanted to be an astronaut*

When I was a kid I wanted to be an astronaut, I was fascinated by space. And, because of all that, I wanted to study physics. My girlfriends wouldn't get it; they hated physics ... As I got older, people kept telling me not to do it and this increased my determination: I had big fights about this with my parents because I wanted to go to the US to study physics.

This story is used to illustrate Sahira's strong interest in physics. As a child, Sahira dreamt of being an astronaut. When she got older she loved physics. During high school in India, her girlfriends hated physics but that did not influence her interest in physics, as one might have expected given the peer pressure that is especially prevalent during teenage years. In the last year of high school, Sahira had decided to go to the United States to study physics, although this was not well-received by her parents, quite typical of a working-class family in India. In the cultural context in which she grew up, it would be considered atypical for a young girl to move out of the family home at a young age without getting married, let alone moving on her own to a different country. As Sahira said, she had to fight with her parents about her decision, which she finally followed through. Again, these words demonstrate Sahira's strong and resilient science identity in terms of interest and performance. At the same time, this story showcases the barriers posed for women in a working-class and more conservative family environment.

Story 4: *You are really good at it, you should do it!*

Throughout high school, every time I answered in class, the [male] teachers were like *Oh, it's you again. Guys, you need to do something. This girl is doing better than you.* That made me feel like I was competing with the boys. The only person who supported me was my last physics teacher. He is incredibly sweet; he is the nicest person I know. He was very supportive and encouraging and he would spend time outside of the class to help us with our assignments. One day he told me: *You want to do physics, right? Leave this country. You know you are really good at this. You will make it.* I would not have decided to leave India and go to the US to study physics if it wasn't for him.

Two things are of interest in this story. The first is the reaction of one male teacher to the fact that Sahira would answer all questions in class. In other words, addressing the male students in the class by emphasizing how a *girl* was doing much better than them is evidence not only of his bias but also of nurturing the stereotypical idea that boys are better than girls in physics. In contrast to this reaction is the explicit recognition made by another teacher. This teacher not only explicitly recognized Sahira as a competent physics person but also actively encouraged her to study abroad. It is also interesting to notice how Sahira described this teacher as "nice and sweet"—attributes associated with a more feminine than masculine performance, which is typically attached to the field of physics. In Sahira's own words, the influence of this teacher was critical for her deciding to study in the United States.

Story 5: *All eyes on me: oh yeah, I am brown*

We are about 5–6 female students in every class of about 30 students. As a woman of color, I feel like all eyes are on me. There are no other students of color. I always

feel that I stand out somehow in the classroom. I have felt singled out by being gazed at for being a person of color. The guys in the class feel very easily threatened because I always get the highest grades. And then, I hear things like: *Indians are smart, that's why*. If I am experimenting with another student, I would notice that his eye would fall on my hand and I'd be like *Oh yeah, I'm brown*. I don't feel like I belong here. It takes someone of color, a woman of color to make me feel like I belong somewhere. I've never experienced that. I only had one female university instructor so far but she is not of color.

This story helps to illustrate what it means to be “the only one”, and in this case, a woman of color in a predominantly White and male-dominated space, such as typical undergraduate physics classrooms in Northwestern Europe. This story speaks to how gender, ethnicity, and race identity intersections serve as barriers to Sahira's sense of belonging. How her gender seems to serve as a barrier to her sense of belonging is apparent through her words about how the male students felt threatened because she received the highest grades. How her ethnic identity plays out becomes prevalent in the words which describe other students' reaction to her being smart because she is Indian. But, perhaps most illuminating in this story is her description of how she experienced a lack of belongingness due to her gender, ethnic, and racial identity intersections, essentially positioning her as an outsider of physics classrooms. A related issue is the lack of representation of women in physics in general, but especially of women of color, who could potentially serve as role models or a support mechanism for female students of color (Figure 2).

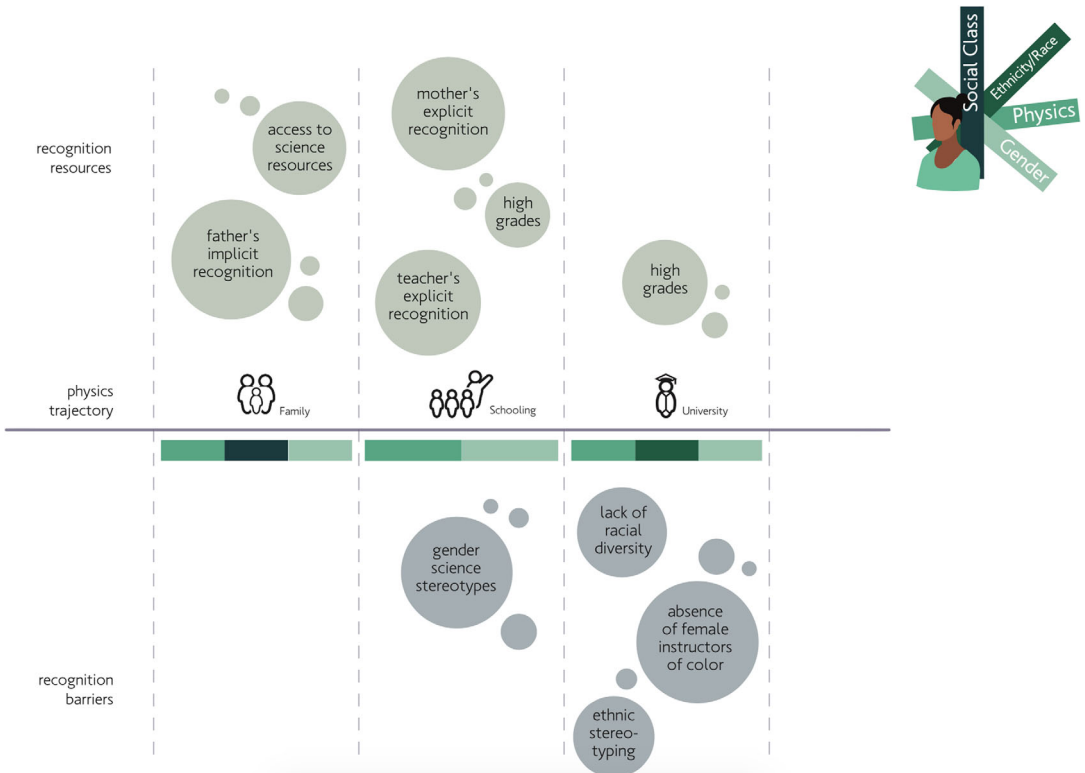


FIGURE 2 Sahira's physics trajectory

5.3 | Zehra: Gender, social class, ethnicity, Islamic, and physics identity intersections

In this section, I share four stories from Zehra's life history that appeared to be critical for her journey in physics. The first story is situated within Zehra's family and broader social community and illustrates the lack of support or family resources being a member of a working-class family living in Eastern Turkey. The second story is situated in high school, where Zehra was explicitly recognized as a competent physics person by one of her teachers who had influenced her decision to study physics. The third story is situated in a secular university context in Turkey, where Zehra experienced discrimination due to her Islamic identity. The fourth and fifth stories are situated in Zehra's current professional career and sociocultural context and serve as evidence of a lack of recognition by her students as well as her social community.

Story 1. *I said physics and they thought physical therapy*

My family environment was conservative: both of my parents are religious and conservative. My parents aren't educated, my father didn't attend high school and my mom didn't even complete primary school. Neither did my older sister attend high school. I never received any advice from my family members, in terms of study and career choices. The decision to study physics was my own because I loved physics and its application to every aspect of life. My parents had no idea what Physics was. When I told them I wanted to study physics they thought I wanted to study physical therapy. But, they never opposed any of my decisions ... this was big for me.

This story sheds light on Zehra's working-class identity and provides evidence not only of the lack of intellectual resources but also of any sense of recognition by her family. In her own words, her parents were unable to offer her any advice concerning studies given that neither of them had a formal education. It is important though to note that her parents never opposed her decision to study, which was perceived as a support act for her. What this story does is illustrate how working-class children lack access to science resources that are usually offered in middle-class and upper-class family environments (e.g., extra science resources and activities). Essentially, the story reveals the inequalities in science, especially in the form of family or intellectual capital, which are evident in working-class children at a very early age. Even though Zehra joined the race behind middle-class children, she maintained a strong desire to study physics and went through it. However, that was not done entirely without any support. As is evident in the story that follows, a high-school teacher had reinforced her desire to study physics.

Story 2. *You are very smart and you have high grades; you can do it!*

Throughout my schooling years, I was really good at physics and math. I wanted to be a doctor. But I never thought that I would study physics because I thought it was too hard. And I don't know why I wasn't confident because I had the highest grades in class ... I had a female physics teacher in high school who also wore a hijab. I looked up at her. And when I told her that I was scared of physics she said: *you are very smart and you have high grades; you can do it*. And that was it! Had it not been for her, I would probably have chosen biology.

Various issues surface from this story that are of interest to this study. First, even though Zehra was a competent learner of physics, she did not feel confident to study physics because it was too hard. This is interesting when viewed in relation to Zehra's gender identity and relevant literature that showcases how female students are less confident than male students, even if they perform better than them. Another important issue that surfaces from this story is the explicit recognition of her high-school teacher who served as a role model for her. It is important to notice here how the two shared specific identity intersections such as science, gender, and Islamic identity. This might be a likely explanation as to why the explicit recognition of this teacher was so influential on Zehra's choice of study.

Story 3. *We were punished because we were wearing a hijab*

Because I chose to study physics at university, I had to attend a secular university, where, however, it was forbidden to wear a hijab. This is discrimination, right? I had to take it off every morning—it was cruel. I felt that I had to sacrifice my religion for physics. We were being punished because we were religious; because we were wearing a hijab. It's a different story for men since, [in Western Turkey], they don't wear anything that might indicate they are Muslims. During graduate studies in the US, I had to face a whole new challenge: people questioned the fact that I was a physicist because I was wearing a hijab.

This story is situated in the Western part of Turkey, which embraces progressive, secular, Western values. In the early 1990s when Zehra was a university student, new governmental legislation passed that forbade women to cover their heads. This is a story that illuminates not only the intersection between gender and Islamic identity but also the negotiations of identity that Zehra had to make: stripping off her Islamic identity for her physics identity. The intersection between Zehra's Islamic religious identity and physics identity was also evident in the context of North America, where Zehra pursued her graduate studies. In her own words, the hijab, as a symbol of Zehra's Islamic religious identity served as a barrier to her recognition as a competent physicist.

Story 4: *Students have more respect for male instructors, especially natives*

Students have more respect for male instructors and especially native ones. I can see it in their evaluations but also in their general attitude in class. I can't put my finger on it, but I can sense it in the way students talk to me versus their male instructors. They speak to them with a lot more respect and admiration. One day I was co-teaching with a male colleague and I was leading the lesson. I was trying to get students' attention but they kept on talking to each other until he asked them to stop talking. I'm not sure if it has to do with the fact that I am a woman, non-native, young, or Muslim. You know, I have so many things working against me [laughs].

This story serves to illustrate Zehra's perception of how her various identities intersected and served as barriers to her recognition by students. Several identities seem to be intertwined in this story: cultural identity influenced by migration processes, age, gender identity, physics identity, and Islamic religious identity. These identities, as she also states, are working against her, especially in the context of physics, which has traditionally been a place reserved for older, white males and who are socially perceived to be in contention with religion.

Story 5: *They do not even think that we are capable of learning a second language*

As a migrant to this country, I don't feel like I belong here. I don't feel very welcomed...I can *sense* how people look at me, I don't know how to define it but I can feel...islamophobia. I always feel that I'm an outsider. A question that I often get from people when they hear that I'm Turkish is: *How come you know English?* One day, a handyman came to the house to fix something, and he said: *I'm surprised that you speak English because most Turkish people don't even speak [the national language]*. They don't even think we are capable of learning a second language, can you imagine how he would react if I told him that I am a physicist?

This story illustrates Zehra's lack of a sense of belonging in society but also her perception of herself as an outsider not only because she is a migrant but also for expressing her Islamic religious identity. Moreover, this story touches upon Zehra's lack of recognition by the social community in which she lives due to her Turkish ethnic identity. As perceived through her interaction with the handyman, she was not recognized as a person capable of learning a second language, not to mention as a physics university instructor. This lack of recognition is tied to misconceptions, cultural stereotypes, and prejudices that are prevalent in Northwestern Europe, and this all comes at a psychosocial cost. As apparent in Zehra's words, she lacks a sense of belonging in the sociocultural context where she has lived and worked for the past 4 years (Figure 3).

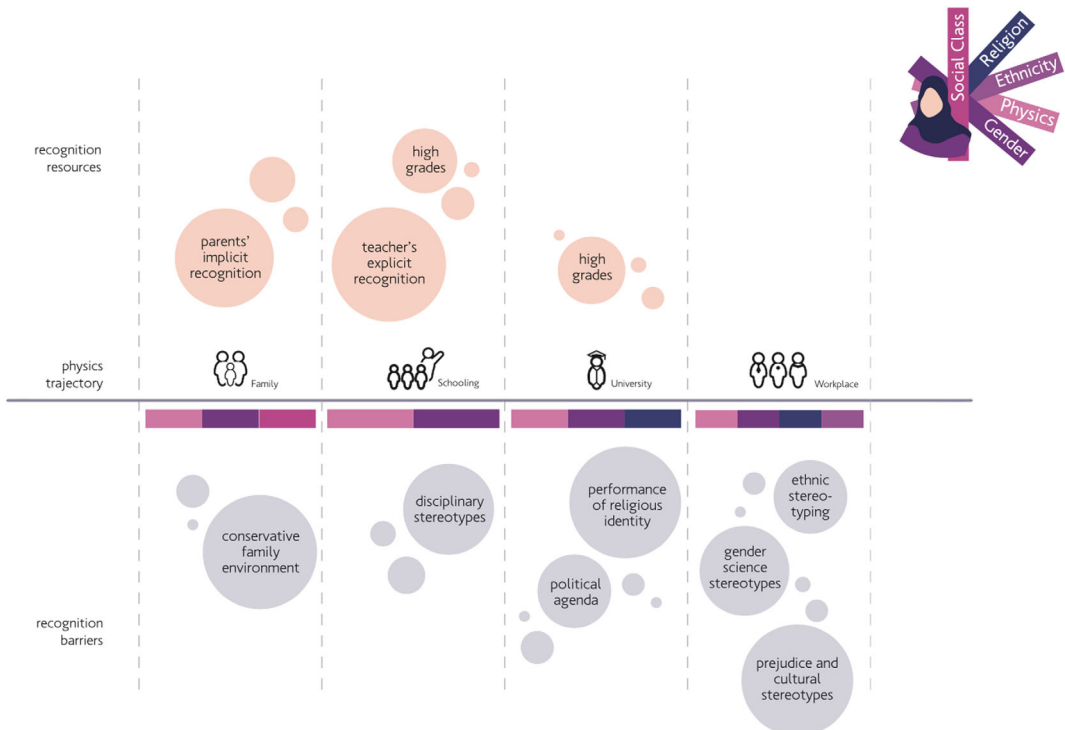


FIGURE 3 Zehra's physics trajectory

6 | DISCUSSION

The three life histories presented in this article encapsulate the pathways by which women form physics identities and bring to light the struggles, conflicts, barriers, and discrimination they meet throughout their lives. Collectively, these stories of forming physics identities tell stories of otherness, persistence, hope, and failure. They showcase how the three women authored multiple identities that simply co-existed for them, while for others, at times, were seen as contested identities and caused misrecognition. More narrowly, the findings point to four main insights: (a) recognition is neither linear nor binary and it comes in many different forms that range from explicit encouragement to silence; (b) it is drawn upon various sources including ones in the early years of life: family, school teachers, university instructor, students, and social community; (c) it is culture-dependent and as such, it is influenced by factors on multiple levels, including cultural and gender stereotypes, organizational policies, racism, sexism, classicism, and other forms of discrimination.

The findings are structured around the two research questions: (a) experiencing recognition throughout trajectories in physics; and, (b) intersecting identities across time and place. In what follows, I discuss the findings through a compare–contrast approach for each of the three participants' life histories across the two themes. This was deemed appropriate as the two questions not only intertwine but are mutually inclusive given that specific identity intersections were essentially the cause of a lack of recognition. The discussion is organized following a time/place approach, which situates the stories in three unique time/place periods of the participants' lives: (a) recognition by family; (b) recognition by the school and university teachers; (c) recognition by peers, students, and other communities.

6.1 | Implicit and explicit recognition by family

Similar to the existing knowledge base, the findings of this study revealed that recognition by the family played a critical role in the three women's study and career choice (Bleeker & Jacobs, 2004). However, the findings of this study offer additional insights into the kinds of recognition by the family and how that is tied to social-class and cultural identities. Growing up in the eastern part of Turkey, in a working-class and culturally conservative family without a formal education, Zehra had no access to resources, experiences, or other forms of support to engage with science. She shared no stories of opportunities to engage with science either through field trips to museums, watching science documentaries, or even through conversations about science at home. However, as Zehra said, her parents did not oppose her study or career decisions, which contradicts the cultural norms of a traditional Turkish family (Özmen & Dönmez, 2013). Zehra perceived this act as an act against social rules and expectations that served not only as approval but as a form of implicit recognition for her. Intersections of gender, social class, and science identities become prevalent here and might also imply a form of resistance to cultural expectations and norms.

Maxine, on the other hand, who grew up in an upper-class family environment in North-western Europe had access to a wealth of resources and opportunities to engage with science in the form of investigations, experimenting with scientific tools, and conversations about science at home. Most notable perhaps is the influence of her father who intentionally challenged the limitations of social stereotypes about women's potential (i.e., being adventurous, traveling to the moon) through storytelling. This explicit recognition provides evidence of Maxine's rich

science capital (Archer et al., 2015) and it is entangled with social-class, gender, and science identity intersections.

Sahira's experiences and recognition by her family are somewhere in between Maxine's and Zehra's. On the one hand, as a member of a working-class family with a father working on ships and a mother as a housewife, Sahira lacked the experience of role models and access to a wealth of science-related experiences, such as visiting science centers and opportunities to experiment with scientific tools, as was the case with Maxine. On the other hand, Sahira was involved in science conversations at home with her father and brother, which reflects implicit recognition of her as a science person. While her mother explicitly recognized her as a competent physics person and supported her decision to study physics, this encouragement was largely tied to her mother's aspiration to see Sahira financially independent of men, which points to intersections between gender, social class, and patriarchy.

What these findings suggest is how important it is to adopt an intersectional lens to examine recognition for women in physics. Had it not been for an intersectionality lens, one would assume that Zehra and Sahira did not experience recognition by their families and that they had no access to science resources. However, for them, recognition took different forms and was tied to different aspirations. In the case of Zehra, recognition was expressed in the form of "no opposition." In the case of Sahira, her mother's recognition was tied to the aspiration of seeing her daughter escape patriarchy through a career in science. Interestingly, both women, unlike Maxine, described how different cultural barriers helped them become more resilient to succeed in science. One could then argue that resilience served as a form of capital, which has been neglected in contemporary literature of science capital. Science capital refers to science-related forms of cultural and social capital, such as parents with scientific careers, visits to science centers, and access to science resources and tools (Archer et al., 2015). Building on large-scale data with youths between 10 and 14 years old, in the United Kingdom, Archer et al. found that children from families with more science capital were more likely to want to pursue science at school and as a career. The findings of this study contradict these findings and instead point to the embodiment of resilience as a coping mechanism as well as a major force of persistence and success in physics.

6.2 | Explicit recognition by teachers

The findings revealed that all three women experienced explicit recognition by at least one teacher or instructor in their home countries, at critical points in their lives when they had to make study or career decisions. In all three cases, the recognition was explicitly articulated through words of validation and encouragement, and also expressed in the form of care and extra attention. These findings are in accord with existing literature, which points to the importance of recognition by teachers (Hazari & Cass, 2018). Similar to the findings of this study, Wang and Hazari's (2018) study showed that recognition by teachers might come in different forms, either explicitly or implicitly through high expectations and challenges, extra attention, and extra time outside of school.

The findings of this study move beyond characterizations of the type of recognition to bring forward specific identity intersections entangled with recognition: gender, social-class, Islamic religious identity, ethnic identity, and single motherhood. At the same time, the findings also reveal the identities of the teachers who explicitly recognized the participants as competent physics learners. In the case of Maxine, the female physics instructor who appeared to have a

critical impact on her sense of belonging was a radical feminist, an identity that Maxine also identifies with. In the case of Zehra, the high-school teacher who influenced her study choice of physics was also female, Turkish, and wore a hijab. Sahira's case differs since the high-school teacher who supported her was an Indian man whom she admired and described as "sweet" and "kind". What is interesting to highlight here is that these two characterizations are usually attributed to more feminine gender performances and are in contrast with the masculine and often dehumanizing culture of physics (Francis et al., 2017).

Collectively, these findings speak to the importance of having visible minority role models from different ethnic, religious, racial, and socioeconomic backgrounds, who exhibit a variety of gender performances and communicate explicit recognition for students at critical points of their trajectories in physics.

6.3 | Misrecognition by peers, students, and social community

All three women experienced different types of recognition in the university context in Northwestern Europe that were connected to various kinds of identity intersections. Sahira currently experiences recognition by her peers as a competent physics person because she receives high grades. However, as a female student of color in a predominantly male-dominated white space, Sahira does not experience a sense of belonging. This lack of a sense of belonging might be attributed to the intersection of two identities, gender and racial, that position her as an outsider in this context. In her own words, Sahira is constantly reminded of her skin color; a brown body that stands out in a predominantly white space (Ong, 2005). Interestingly, ethnic identity does not seem to be a factor that plays out in her lacking a sense of belonging, which might be attributed to the fact that Sahira studies at a university where more than a third of the student population is international.

On the other hand, Maxine and Zehra have been dealing with different barriers, experiencing a lack of recognition, as well as a lack of a sense of belonging in academia. Similar findings were revealed in Rosa and Moore-Mensah's (2016) study, which explored the life histories of six African-American women in physics through interviews. The findings of their study showed that all participants felt isolated in academia, especially as members of study groups, in which they felt excluded.

For Maxine, these barriers were found at the intersection of her gender and single motherhood identities. While these identity intersections placed her in a disadvantaged position to men, when compared with Sahira and Zehra, she was privileged. Maxine spoke about the gendered culture and practices within academia in general and physics in specific, and her failure to balance a scientific career with family responsibilities. These obstacles have been well-documented in related literature and provide evidence of gendered practices and policies in academia for women, and especially in the highly competitive field of science (Howe-Walsh & Turnbull, 2014).

For Zehra, these barriers were found at the intersection of her gender, social class, ethnicity or migration background, and Islamic religious identity. As apparent in the findings, Zehra experienced a lack of recognition by her students as well as her social community. Zehra spoke of a feeling of marginalization caused by how people look at her—essentially, an experience of otherness. This feeling and experience might be best described through what Foucault in 1977 called the "network of gazes"—a process of conducting Muslims as "others" (Davidson, 2009). This lack of both actual and perceived recognition that Zehra experienced speaks to the politicized nature of recognition, which is tied to misconceptions, cultural stereotypes, and prejudices that are prevalent in Northwestern Europe: Turkish male migrants are perceived as uneducated, low-skilled workers, and Muslim women are perceived as being oppressed and

lacking agency (Jones et al., 2018). These findings illuminate the complexity of identity intersections that women in physics confront and call for intersectional approaches to examining the politicized nature of recognition.

7 | GAZING FORWARD

7.1 | Practice

The findings of this study offer further evidence to the existing knowledge base that suggests that no more programs to “crack the gender code” and to attract more women in physics are needed because the problem is not one of attracting women but one of retaining women in physics. Instead, the findings of this study speak to the need for systemic programs on how women are recognized by others; programs that seek to improve physics learning and working environments from the school level to the professional, aiming to provide gender-inclusive spaces where women experience recognition. Some direct support measures both within schools and academia have been suggested by previous research, which can also be drawn out of the findings of this study, such as, STEM programs for undergraduate and graduate students that serve underrepresented students as well as STEM counter spaces, which have the potential to disrupt the privilege of the dominant culture of STEM, provide explicit recognition, mentoring, and visible minority role-models (Carpi et al., 2017; Ong et al., 2018; Wilson & Kittleson, 2013). However, the most crucial challenge, as revealed through the findings of this study, is how to disrupt the schooling and academic culture to challenge assigned identities that exclude women from physics, and to renegotiate organizational power in physics. A wealth of research evidence shows that the structures and culture of schooling and university are alienating and intimidating for women. This is especially true of physics, which remains a heavily male-dominated field characterized by a white, masculine, elitist, racialized, and atheist culture (Avraamidou, 2020b; Gonsalves & Danielsson, 2020).

7.2 | Research

An exploration of identity-based research in science education reveals the paramount importance of recognition of the formation of science identity in general and physics identity in particular (Hazari et al., 2010; Hazari & Cass, 2018). However, recognition has been conceptualized through a binary and dichotomous approach and provided limited insights on how distinctive structures of oppression can manifest in complex patterns and forms of misrecognition, especially for women belonging to minority groups. What is currently missing from the existing knowledge base is an exploration of how certain people are *not* recognized, meaning, an exploration of the *politics of recognition* and how they play out in the formation of physics identity and especially in nurturing women's persistence to enter and stay in science. Paying attention to the politics of recognition and exploring who is being recognized and who is made vulnerable, how, where, and by whom would serve as a first step toward addressing the issue of the underrepresentation of women in physics. The findings of this study contribute toward this goal.

Such an exploration provides an opportunity to examine the political dimensions of physics identity related to power, racism, sexism, classicism, and religious exclusivism. This is precisely where the contribution of this study lies as it provides evidence of the exclusion and suffering caused both through lack of recognition as well as misrecognition, by comparing and

contrasting three unique life stories of women in physics. The findings of this study essentially reveal the kinds of identities, and consequently the bodies as well as the associative objects with cultural meanings that are deemed in-place (i.e., native, male) and those that are deemed out-of-place in physics: woman, migrant, single mother, brown body, and the hijab.

The life history approach to tracing how the three women experienced recognition throughout their studies/careers in physics yielded rich insights and was able to uncover events and experiences not easily accessible otherwise. As the participants' stories illustrate, their physics trajectories were influenced by myriad interactions, events, and experiences that caused shifts on their way of *becoming* a physicist, which go well beyond gender. Hence, any effort to make physics more equitable ought to pay attention to all the intersectional factors (i.e., social class, race, religion, ethnicity, migration background, and motherhood) that marginalize, exclude, and discriminate women through their struggle for recognition. Nevertheless, I do acknowledge that this study provides only a glimpse of the politicized nature of recognition which women in physics have to tackle, especially those who belong to minority groups, and that further research is needed to gain a more comprehensive and generalizable understanding of how recognition works in different places and supports or hinder persistence. As related studies have shown, persistence is directly related to different intersections, including gender, social class, and culture, especially of first-generation college students (Wilson & Kittleson, 2013). An underexplored question in identity-based research is how persistence relates to recognition and how might culture, gender, racial, social-class tensions be addressed through an exploration of recognition?

Related crucial questions that remain largely unexplored are: Who is recognized as a competent physicist? How is lack of recognition or misrecognition tied to the formation of women's physics identities? How do recognition and persistence relate? How is recognition constituted within contemporary power structures, sexism, classicism, and elitism in physics? How does place shape recognition, especially of women with a migration background? How are boundaries in terms of recognition drawn and redrawn in physics participation? These questions point to the social and political importance of recognition in the formation of physics identity. Hence, a thorough investigation of the cultural meanings of recognition as well as its politicized nature is warranted to understand its role in the reproduction of power structures, inequality, and exclusion of women from physics.

7.3 | Theory

From a theoretical perspective, this study problematizes and challenges two issues in physics identity research: (a) how the construct of recognition has been used might serve the status quo and perpetuate inequalities; (b) a non-intersectional conceptual approach provides a narrow and partial understanding of the experiences of women in physics.

Despite its value in understanding the struggles that women face as being constructed as outsiders in physics who seek validation, recognition comes with certain limitations. A fundamental limitation lies within its very conceptualization: while it has been conceptualized as an integral component of social justice it might serve to perpetuate injustice and to maintain power structures between the ones who struggle for recognition of their subjectivity and the ones to confer recognition. As Oliver (2015) argued, the problem with the concept of recognition is that "it can limit the flexibility of a theory, making it hard for it to accommodate the complexities of intersubjectivity, especially the interrelationships between subjects and their environments" (p. 476). Instead, a more radical conceptualization of recognition is necessary that opens up the possibility of considering both socio-political context and the intersubjective constitution of

subjectivity (Oliver, 2015). Or, perhaps, as Butler (1993) argued, we need to conceptualize *recognition as action* which implies more than “seeing as” and requires action on what we recognize. This is important because justice is not actually served when recognition is served, but instead as Oliver (2015) argues, justice requires holding open the possibility of something beyond recognition” (p. 478).

A non-intersectional conceptualization of physics identity that ignores personal histories, subjectivities, diversities, and individual needs by idealizing certain behaviors and practices (e.g., whiteness, masculinity, individualism) and essentially cutting off others (e.g., femininity, Blackness, motherhood, religious identity) only serves to reproduce the status quo and further generates power structures and inequalities in physics. As Ong (2005) argued, “historically, Western culture has popularized and celebrated the confident, and sometimes even arrogant, white male as the typical or ordinary icon of intellect and scientific competence” (p. 597). As a result, anyone unable to perform these kinds of identities has been traditionally unrecognized, perceived as out-of-place, marginalized, and excluded from physics. More importantly, a conceptualization of physics identity that does not value people for who they are in their entirety made up of multiple and intersectional identities, but only values how people produce or consume scientific knowledge is exclusionary and only serves to permit more minoritizing. For an exploration of women’s participation in physics, as evidenced in the findings of this study, any attempt to examine gender in isolation instead of as an intersection with other multiple identities is an ill-equipped way of examining the complexities and dynamics of contemporary identity politics embedded in physics (non)participation. As Holland et al. (1998) argued,

None of us is occupied singularly: we are not possessed by one identity, one discourse, one subject-position. Each act is simultaneously a social dynamic, social work, a set of identifications and negation, an orchestration or arrangement of voices (p. 211).

This study, then, is offered as an attempt to disrupt monolithic theorizations of physics identity and to argue instead that the value of physics identity can be found at its intersection with multiple other and distinct identities. In so doing, I argue that researchers ought to abandon conceptualizations of distinctions between multiple identities as boundaries, but instead conceptualize them as a horizon: “not that at which something stops but that from which something begins its presencing” (Heidegger, 1971, p. 152).

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