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The Role of Attitudes and Social Perceptions in Students' Motivation towards Learning Physics

Fahimeh Karami-Garehgeshlagi[*,1], **Pardis Amiri**[1]

[1]*Department of Physics Education, Farhangian University, Tehran, Iran.*

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1 .Corresponding author:
fa.karami@cfu.ac.ir

ABSTRACT

Physics education is not merely a process of transmitting purely scientific concepts, but rather a social and cultural context in which various values, identities, and inequalities are reproduced. The sociology of physics education, by examining different social factors such as gender, social class, culture, and scientific identity, seeks to provide a deeper understanding of how students learn and participate in this field. Recent research indicates that cultural beliefs, social perceptions, and even gender stereotypes regarding who can be a successful scientist or physicist play a significant role in students' interest and performance in this subject. Furthermore, classroom interactions in physics, modes of address, body language, and the assessment climate limit learning opportunities for certain groups. Hence, a sociological understanding of physics education assists teachers in designing more equitable and effective learning environments. This article, through a qualitative analysis reviewing recent studies in the sociology of science and physics education, examines the relationship between social and cultural structures and learning processes. The findings of this study highlight the necessity of attending to cultural and social contexts in physics education and propose strategies for promoting educational equity and fostering scientific identity among students as an impactful and essential undertaking.

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INTRODUCTION

Physics education is initially perceived as the transmission of a set of scientific laws and concepts; however, this process in fact occurs within a complex cultural and social context. The learning and teaching of physics are not limited merely to understanding natural phenomena but are also influenced by values, norms, and social structures [1]. The sociology of physics education, by examining these social dimensions, seeks to understand how cultural, gendered, and class contexts affect students' learning and attitudes toward physics [2]. In recent years, researchers have demonstrated that the cultural image of a physicist as a 'real scientist' is often intertwined with characteristics such as being male, possessing extreme rationality, and being detached from emotions. This type of representation causes groups such as girls or students from diverse cultural backgrounds to feel a lower sense of belonging to the discipline [3], although these conditions are gradually moving toward improvement and greater equity. Such perceptions not only influence students' choice of academic field but also impact their self-confidence, classroom participation, and the formation of their scientific identity [4]. From a sociological perspective, physics education must be viewed beyond the transmission of scientific knowledge and examined as a social activity in which teacher-student interactions, assessment practices, and educational content are all capable of reflecting structures of power and inequality [5].

All the aforementioned considerations assist us in shifting focus beyond mere physics concepts toward the social and cultural contexts of learning, thereby ensuring that all students have equal opportunities to comprehend and develop scientifically [3]. Thus, the sociological examination of physics education not only contributes to enhancing the quality of teaching and learning but also reduces gender and cultural gaps while promoting educational equity. Drawing upon recent research, this article seeks to provide a review-based analysis of the literature on the role of social factors in physics education and to propose strategies for creating more equitable and effective learning environments aimed at increasing student motivation.

Theoretical foundations and research background:

Sociology of science is a branch of sociology that studies science as a social institution and social activity. Its primary focus is to understand how social, cultural, economic, and political factors influence the production, content, dissemination, and application of scientific knowledge. In simpler terms, the sociology of science examines how science operates within society and how it is, in turn, shaped by society. This field analyzes science not as a separate and privileged domain, but as a phenomenon embedded within a social context. Through this sociological approach to science, learning physics is understood not merely as the transmission of knowledge, but as a social and cultural process wherein students, through interaction with their environment and others, construct their scientific identity [1]. The concept of scientific identity refers to the extent to which an individual perceives themselves as someone capable of understanding and doing science, and the degree to which others recognize this role in them [2]. According to the model proposed by Carlone and Johnson, the formation of scientific identity depends on three core components: scientific competence, scientific performance, and recognition by others. For instance, a student may possess talent and perform well in physics, yet if they are not recognized by their teacher or peers as a capable science person, or if their scientific persona is not socially validated, a robust scientific identity will not develop. From Bourdieu's perspective, this process can be explained through the concepts of cultural capital and the educational field [5]. Metaphorically, the scientific field resembles a field or playing ground, as conceptualized by Bourdieu. In his view, the scientific field is an autonomous and specialized social arena or space wherein its actors, such as scientists in that discipline, compete to acquire symbolic capital, including credibility, reputation, and scientific trust. Within the educational system, specific values and expectations such as logical thinking, the formal language of science, and mathematical proficiency are recognized as privileged forms of symbolic cultural capital [3]. Individuals who do not possess these forms of capital may experience feelings of exclusion or alienation during the learning process, even if they possess high scientific ability [3,5]. More recent studies in the sociology of physics education indicate that the formation of scientific identity is not limited to individual skills but is also associated with gender, social class, and family culture [3,4]. For example, research has shown that many girls, particularly in traditional and under-resourced educational environments, perceive physics as a masculine discipline, and consequently experience a lower sense of belonging to the field [3]. On the other hand, students from families with low cultural capital may also have a limited understanding of the scientific applications of physics, which hinders the reinforcement of their scientific identity [4]. studies demonstrates that scientific identity formation occurs across three levels: individual, institutional, and socio-cultural. The individual level encompasses beliefs, motivations, and feelings of scientific self-efficacy. The institutional level corresponds to the role of the educational system, assessments, and classroom interactions. The socio-cultural level aligns with societal stereotypes, expectations, and values concerning science. Understanding these three levels assists teachers and researchers in designing more equitable and participatory learning environments, enabling all students, regardless of gender, cultural, or social background, to envision themselves as potential physicists and to thrive [6-9].

METHODOLOGY

This systematic review was reported in accordance with the PRISMA 2020 statement. To this end, the review process comprised the stages of identification, screening, eligibility assessment, and ultimately analysis of the selected studies. In the first step, a comprehensive search was carried out in educational article databases to identify studies relevant to the topic. Keywords were selected to cover all possible combinations of terms related to the sociology of science, class stratification in physics education, and the impact of gender in physics education. A total of 89 articles were identified, which, after the removal of duplicate records, entered the screening phase. In the second stage, titles and abstracts were meticulously examined, and irrelevant articles were excluded based on predetermined criteria. Inclusion for analysis specifically required the study's relevance to formal educational settings, namely schools or universities and its focus on the sociology of science and physics. During the full-text eligibility assessment phase, 27 articles were thoroughly reviewed. Among these, 11 articles were excluded due to non-compliance with the requisite criteria, and ultimately, 16 articles were selected for analysis. In the final step, the extracted data from the selected articles were organized into a table and coded using a hybrid deductive and inductive approach. Various dimensions, including research context, social approach, cultural differences, and gender segregation, were considered. Finally, a qualitative analysis was conducted based on these data to identify the main patterns and findings.

RESULTS AND DISCUSSION

Following the review of articles and research conducted in this field, the predominant themes examined can be categorized into three main areas: the issue of gender and physics education, socio-economic inequality and access to physics education, and institutional structures and teaching methodologies.

Gender and Physics Education: Sociological studies have demonstrated that gender is a key factor in students' learning and scientific identity [2]. In physics educational environments, girls frequently encounter challenges rooted in cultural and social stereotypes. These rigid and doctrinaire cultural mindsets lead girls to less frequently envision themselves in the role of a physicist and to possess lower self-confidence in this discipline [4]. In many traditional societies, cultural structures, by perpetuating gender perceptions, legitimize the prevention of girls' educational continuation as a normative practice. This directly results in the systematic exclusion of half the population from accessing cultural capital and participating in specialized fields. At a more complex level, in societies where educational opportunities for girls appear ostensibly available, we witness the emergence of patterns of invisible gender segregation in academic choice. In these societies, deeply entrenched beliefs reinforce the humanities and social sciences as domains congruent with women's presumed inherent attributes, such as emotionality and verbal skills. Conversely, the basic sciences, technical and engineering fields, and particularly the discipline of physics, are defined as masculine territory requiring instrumental rationality and visuospatial abilities. These stereotypes are instilled and internalized in girls through various mechanisms, including family expectations, the orientation of academic counselors, textbook content, and peer interactions. The consequence of this process is a marked decline in girls' inclination and self-efficacy to enter fields such as physics. Consequently, even in the absence of formal prohibition, these cultural perceptions function as a formidable informal barrier, resulting in a gendered imbalance in the distribution of basic science disciplines and the perpetuation of a gender gap in the relevant domains. One of the most significant findings in this area is that classroom climate, grouping practices, and the selection of instructional examples can play an influential role in students' learning experiences [1]. For instance, female students exhibit lower participation and a diminished sense of belonging in classrooms where activities are distributed unevenly between genders or where examples are predominantly aligned with boys' experiences [4]. Theoretically, girls' scientific identity is shaped by three core components: scientific competence, scientific performance, and recognition by others [2]. A substantial body of research indicates that even when girls demonstrate high scientific competence, the absence of recognition from teachers and peers impedes the formation of a robust scientific identity [3]. More recent studies emphasize that reducing the gender gap in physics education necessitates the design of targeted educational interventions. These include balanced student grouping, encouraging girls' active participation, and selecting examples and projects relevant to the experiences of all students. Such measures not only positively influence academic performance but also enhance girls' motivation, self-confidence, and sense of belonging within the educational environment [3]. Accordingly, an examination of gender issues in physics education reveals that without attention to social and cultural factors, physics education cannot achieve educational equity or foster scientific identity among all students.

Establishing equitable and supportive learning environments for all genders is essential for academic growth and active classroom participation.

Socio-economic Inequality and Access to Physics Education: Social and economic inequalities are among the most significant factors influencing opportunities for and the quality of physics learning [3]. Research has demonstrated that students from low-income families typically have access to more limited educational resources, including laboratory and workshop equipment, remedial classes, and support from experienced teachers, to name but a few examples. These constraints produce a gap between students from different social strata, diminishing both their deeper comprehension of scientific concepts and their motivation to achieve [4]. From a theoretical perspective, families' cultural and economic capital plays a crucial role in their children's educational orientation [5]. Families who place greater value on science education generally provide a richer environment for inquiry, experimentation, and experience, whereas in under-resourced communities, education tends to be largely confined to rote memorization and examination success [1]. Such disparities contribute to physics being perceived as a difficult and inaccessible subject for certain students [2]. The combination of socio-economic inequality with the specific characteristics of physics education further deepens this gap. The distribution of qualified and motivated teaching personnel is starkly unequal between advantaged and disadvantaged regions. Schools in disadvantaged regions frequently face a shortage of specialist and experienced physics teachers. Effective physics instruction requires well-equipped laboratories, workshops, and educational aids. School budgets, which are often dependent on charitable contributions and the local economy, determine the level of such resources. During the COVID-19 pandemic, this gap became starkly evident through unequal access to virtual learning environments and digital tools. In schools located in deprived areas, emphasis is often placed on rote memorization, whereas in advantaged schools, fostering creativity and scientific thinking is prioritized. Furthermore, the perception of educational inequality among disadvantaged students can lead to diminished motivation and academic burnout. The existence of various school types, including selective schools, gifted schools, non-profit private schools, and state-funded exemplary schools, each admitting students based on specific socio-economic or cognitive criteria, results in segregation and the creation of class-based education. This segregation increases class homogeneity and reduces social mobility, which was once a primary function of education. In recent years, researchers have emphasized the necessity of equitable access to practical and experiential learning opportunities [3]. Providing more affordable educational tools, utilizing digital technologies for experiment simulations, and training teachers to recognize social and economic barriers have been introduced as key strategies [10]. Such approaches can assist students in disadvantaged areas in attaining a more authentic and meaningful experience of learning physics. Consequently, socio-economic inequalities affect not only academic performance but also scientific identity and perceived self-efficacy in the physical sciences. Equality of access to quality education is a fundamental condition for nurturing the next generation of physicists and physics educators, who may emerge from any social stratum [3,4,10].

Institutional Structures and Teaching Methodologies: Institutional structures, including educational policies, school culture, and the organization of educational systems, profoundly influence how physics is taught and learned [3]. In many countries, physics education remains rooted in traditional, transmission-based approaches, wherein the teacher is positioned as the primary source of knowledge and students are mere recipients of information. Such an approach not only impedes the development of critical thinking skills and creativity but also engenders a sense of detachment from scientific content among students [1]. Educational institutions often play a role in reproducing patterns of power and inequality. Research has demonstrated that schools and universities typically possess structures that inadvertently marginalize specific groups of students, such as those from lower socioeconomic backgrounds or girls [2]. This situation diminishes equal opportunities for engagement in laboratory and scientific activities [4]. Regarding teaching methodologies, shifting from lecture-based and rote memorization models toward active learning and inquiry-based learning approaches constitutes one of the most critical steps in improving physics education [11]. In these approaches, students assume a more active role in constructing their own knowledge, attaining deeper understanding of physical phenomena through discussion, experimentation, and collaborative group work. To this end, budget allocation and educational resources must be strategically directed to particularly strengthen schools in disadvantaged areas. This includes recruiting and empowering physics teachers through incentives and continuous professional development programs. Moving toward reducing the proliferation of diverse school types and strengthening standard public schools with high quality can also contribute to mitigating class-based segregation and fostering heterogeneous educational environments, which themselves constitute opportunities for learning. A centralized curriculum that emphasizes rote memorization and theoretical concepts lacks the flexibility required to address local needs and students' interests. This approach constrains the creativity of both teachers and students, rendering physics education an unengaging process. Furthermore, an overemphasis on standardized tests featuring multiple-choice questions eliminates the applied and analytical dimensions of physics, steering teachers toward 'teaching to the test.' This phenomenon overshadows deep conceptual understanding and diminishes students' motivation to learn physics as a dynamic body of knowledge. Teaching methodology, serving as a mediating factor, can either amplify or mitigate the impact of institutional structures. Consequently, institutional structures and teaching methodologies not only affect the transmission of scientific concepts but also play a fundamental role in shaping students' attitudes, scientific identity, and sense of belonging to the scientific community [1,3,11].

RECOMMENDATIONS

Given the aforementioned challenges concerning gender, economic, and structural inequalities, researchers in physics education emphasize that transforming attitudes and educational structures is only feasible through targeted, multidimensional interventions [3]. These interventions must be implemented both at the level of formal education, such as schools and universities and at the policy-making level to ensure equitable participation opportunities for all students.

One of the most effective approaches is the pre-service and in-service training of teachers with a focus on inclusion and educational equity [10]. Teachers who are cognizant of cultural, gender, and class differences can foster a safer and more equitable learning environment for physics education. Teacher empowerment programs should incorporate workshops on unconscious bias, the design of diverse group activities, and non-traditional assessment methods [11].

Furthermore, revising curriculum content plays a pivotal role. Many physics textbooks still perpetuate androcentric or elitist historical perspectives, overlooking the contributions of female scientists and those from non-Western societies [2]. Rewriting this content with an emphasis on cultural, social, and gender diversity can present a more authentic and inspiring image of science [1].

At the institutional level, policymakers should allocate increased financial resources to under-resourced schools to equip them with instructional tools, well-equipped laboratories, and emerging technologies such as digital physics simulations [10]. Such

investments not only enhance access but also foster students' learning motivation and scientific self-confidence, thereby contributing to educational equity [4].
Finally, for future research, it is recommended that cross-cultural studies be conducted with epistemic insight into social customs in order to longitudinally assess the genuine impact of these interventions. Collaboration among universities, schools, and local communities can establish a sustainable model of equitable and participatory physics education [3].

CONCLUSION

A sociological examination of physics education reveals that learning science is not merely a cognitive or technical process, but rather a social and cultural phenomenon profoundly shaped by gendered, class-based, and institutional structures [3]. Students from different social classes and genders enter educational environments with unequal opportunities, expectations, and cultural capital, a disparity that directly influences their scientific identity and future trajectories in the field of physics [2,4]. From the perspective of the sociology of science, achieving inclusive and equitable physics education necessitates transforming the educational system from a closed, transmission-based structure into a dynamic and participatory framework wherein all students, regardless of gender or socioeconomic status, have the opportunity to experience and exercise agency within the scientific process [1].
In sum, this article has demonstrated that equity in physics education is not only an ethical imperative but also a scientific and social necessity. Effecting sustainable change requires reforms in educational policies, teacher training, curriculum revision, and the provision of equitable access to resources [3,10]. Finally, future research should adopt an interdisciplinary approach to more precisely investigate the impact of social factors on the understanding of physics concepts, thereby transforming science education from a restricted, elitist activity into a humane, equitable, and participatory process [1,3].

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