East African Scholars Journal of Education, Humanities and Literature
Abbreviated Key Title: East African Scholars J Edu Humanit Lit
ISSN 2617-443X (Print) | ISSN 2617-7250 (Online) |
Published By East African Scholars Publisher, Kenya
Volume-2 | Issue-12 | Dec-2019 | DOI : 10.36349/EASJEHL.2019.v02i12.011

OPEN ACCESS

Research Article

Equity in Action: Intersectional and Interdisciplinary Strategies for Advancing STEM Opportunities for Girls of Color

Sharon A. Ndubuisi[1*], Alisa Ochanya Tony[2], Mahani Soale Fuseini[3]

[1]Florida State University, United States
[2]Harrisburg University of Science and Technology, United States
[3]Springfield College, MA, United States

*Corresponding Author
Sharon A. Ndubuisi

Abstract: This paper explores the intersectional and interdisciplinary factors that shape access to STEM education and digital literacy for girls of color. Drawing on data from UNICEF (2019) and secondary research conducted prior to 2020, the analysis reveals that systemic inequities persist across three key areas: digital access, skill acquisition, and intra-household resource distribution. While global and national efforts have expanded technological infrastructure, these efforts have often failed to address the social and cultural barriers that limit meaningful participation for marginalized girls. Girls of color continue to face digital exclusion due to gendered norms, racialized schooling practices, and unequal support in home and school environments. Applying frameworks of intersectionality (Crenshaw, 1989) and digital divide theory (van Dijk, 2006), this study argues that access alone does not ensure equity. It calls for coordinated, justice-oriented strategies that include culturally responsive pedagogy, community-based mentorship, equitable family practices, and policy reform grounded in disaggregated data. These strategies are essential to dismantle structural barriers and enable full participation of girls of color in STEM. The paper concludes that advancing digital equity is not only a technological challenge but a moral and educational imperative.

Keywords: Digital equity, Girls of color, STEM education, Intersectionality, Digital divide, Culturally responsive pedagogy.

1. INTRODUCTION

Equity in STEM education has been a longstanding challenge, particularly for girls of color whose access to science, technology, engineering, and mathematics pathways is limited by intersecting systems of discrimination. Despite decades of educational reform, they remain among the most underrepresented groups in STEM fields. This underrepresentation is not the result of individual deficits but rather the cumulative effect of institutional bias, structural inequality, and narrow pedagogical frameworks. Understanding and addressing these barriers requires an intersectional approach that accounts for the simultaneous effects of race, gender, and socioeconomic status on educational opportunity and participation (Crenshaw, 1989). The need for equitable STEM education is more urgent than ever, as technological fluency becomes a prerequisite for meaningful participation in modern economies. However, global data reveal persistent gender gaps in both access to technology and the acquisition of digital skills. According to UNICEF (2019), adolescent girls aged 15 to 24 in low- and middle-income countries are significantly less likely than boys to use the internet or possess even the most basic digital competencies. These disparities reflect broader trends of exclusion from digital learning environments and future-ready skill development. They also echo domestic patterns in high-income countries, such as the United States, where girls of color face systemic disadvantages in educational access, resource allocation, and representation in STEM courses and careers (Ong *et al.,* 2011). This gap is not only a digital issue but a social justice concern. Girls of color often inhabit the margins of both educational and technological systems. As van Dijk (2006) argues, the digital divide extends beyond the simple matter of internet access to include differentiated levels of skill, agency, and the ability to convert access into opportunity. In other words, the divide is not merely technological—it is profoundly social. For girls of color, this means that even when devices and connections are

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjehl/

Article History
Received: 30.11.2019
Accepted: 10.12.2019
Published: 28.12.2019

available, usage is often shaped by social expectations, safety concerns, and educational environments that fail to support their engagement.

Intra-household dynamics further compound the problem. Quisumbing and Maluccio (2000) demonstrated that gender-based biases within families influence how resources, such as educational materials and access to technology, are distributed. Girls are more likely to shoulder domestic responsibilities, be subject to restricted screen time, or lack parental support for digital learning. These household patterns often reflect and reinforce broader cultural norms, making them difficult to address without coordinated community and policy interventions. At the same time, schools, often considered vehicles of social mobility, frequently reproduce existing inequalities. According to Scott *et al.,* (2018), many STEM learning environments in the U.S. remain racially exclusive, lacking the cultural responsiveness necessary to support girls of color. Educators may unintentionally hold biases that limit these students' participation in advanced coursework, further distancing them from opportunities to develop the digital and analytical skills central to STEM careers. Moreover, the absence of female mentors and representation in science and technology contributes to a lack of visibility and belonging, discouraging long-term participation (Ong *et al.,* 2011).

Globally, the policy landscape has been slow to respond to these multilayered barriers. While organizations such as the OECD (2018) and the United Nations (2018) have issued calls for inclusive technology access, much of the focus remains on hardware distribution rather than the deeper issues of pedagogical reform and gender equity. UNESCO (2018) further warns that unless educational systems adopt inclusive and human-centered approaches to technology integration, the expansion of digital infrastructure may widen rather than close the equity gap. Despite these challenges, there is growing recognition that transformative change is possible through intersectional and interdisciplinary strategies. By integrating frameworks from gender studies, critical race theory, and education, new pathways can be developed that not only provide access but also foster agency and belonging. These strategies must be rooted in the lived experiences of girls of color and designed to dismantle rather than accommodate existing barriers.

To that end, this paper seeks to investigate long-standing and systemic inequities in digital education through a global and comparative lens. Drawing on UNICEF's pre-2020 data and additional scholarly research, it proposes a model of equity-driven STEM engagement that centers intersectionality and prioritizes inclusive, interdisciplinary interventions. This introduction sets the stage for an in-depth exploration of how the convergence of digital exclusion and systemic bias impacts the educational futures of girls of color. In doing so, it underscores the necessity of bold, inclusive action to reshape the STEM landscape and ensure that equity is not only a goal but a practice.

The research aims of this paper are as follows:

1. To examine global and national patterns of STEM access and digital exclusion affecting girls of color using data before 2020.
2. To analyze the role of intersectionality in understanding systemic barriers in STEM pathways.
3. To explore interdisciplinary educational and policy strategies that promote equitable STEM engagement.
4. To propose practical, evidence-based interventions grounded in social justice frameworks.

2. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

The foundation of this study lies in an intersectional and interdisciplinary approach to understanding educational exclusion, particularly in STEM fields. Intersectionality, as developed by Crenshaw (1989), provides a framework for analyzing how overlapping systems of oppression, such as racism, sexism, and classism, compound to produce unique experiences of marginalization. In the context of STEM education, this means recognizing that girls of color are not simply affected by gender or race in isolation but by their interaction within institutional structures such as schools, households, and labor markets. This framework aligns with the digital divide theory as described by van Dijk (2006), who identifies the digital divide as a layered phenomenon involving not only access to technology but also the skills to use it and the ability to convert those skills into meaningful social and economic outcomes. These distinctions are critical when analyzing the experiences of girls of color. While some may technically have access to devices or internet connections, their opportunities to use those tools for STEM learning are often constrained by social norms, school tracking practices, and family dynamics that do not encourage active digital engagement.

Ong *et al.,* (2011) emphasize the significance of these overlapping factors in their research on women of color in STEM, noting that many experience a persistent sense of isolation, cultural mismatch, and pressure to conform to dominant norms within educational institutions. These pressures are particularly acute in disciplines that have historically excluded women and people of color. Their work reveals that without targeted support structures, early academic interest in science or technology among girls of color often diminishes over time due to cumulative experiences of exclusion. Educational research also points to the role of school climate and culturally responsive pedagogy in either mitigating or amplifying these effects. Scott *et al.,* (2018) argue that many STEM interventions fail because they

do not consider the cultural identities and lived realities of the students they aim to serve. Programs that ignore racialized experiences or prioritize assimilation into dominant academic norms can inadvertently alienate girls of color rather than empower them. Instead, strategies that center student voice, affirm identity, and provide mentorship from individuals with shared backgrounds are more likely to foster a sense of belonging and academic persistence.

At the household level, gender norms continue to play a defining role in shaping how digital tools are distributed and used. Quisumbing and Maluccio (2000) provide early empirical evidence showing that families often allocate resources such as food, education, and healthcare unequally based on gender. These patterns persist in the digital era, where girls may have less time, space, or encouragement to engage with technology. Girls are more likely to be tasked with caregiving or household duties, reducing their availability for sustained academic work or technology exploration. These findings are echoed in UNICEF (2019), which reports that even in households with internet access, boys are more likely to use devices for educational purposes while girls use them less frequently or primarily for communication and entertainment. Globally, systemic inequities in access and skill development have been documented across a range of contexts. The OECD (2018) notes that boys are more likely than girls to be exposed to advanced digital tasks and coding instruction, especially in lower secondary education. These gaps are often magnified in marginalized communities, where resources are limited and gendered expectations are more rigid. Similarly, UNESCO (2018) underscores the critical gap between digital inclusion initiatives and actual outcomes, cautioning that unless technology programs address the social and cultural barriers girls face, they risk entrenching existing inequalities rather than alleviating them.

The role of digital safety is another important but often overlooked aspect of the educational environment for girls of color. While digital platforms offer new opportunities for learning and self-expression, they also carry significant risks, including harassment, surveillance, and exposure to harmful content. The Web Foundation (2018) found that adolescent girls are disproportionately targeted by online abuse, which contributes to increased restrictions on their internet use. Parents, educators, and community leaders may impose limitations in the name of safety, but these restrictions can inadvertently limit opportunities for skill development and confidence-building.

The concept of STEM opportunity must be understood within the broader political economy of education and labor. The United Nations (2018) reports that digital skills are no longer optional but foundational for participation in the global economy. Despite this, the pathways to those skills remain unequally distributed. The World Bank (2018) highlights that unequal education systems reinforce labor market disparities by failing to equip marginalized students with relevant competencies. This suggests that bridging the digital divide for girls of color is not simply an educational task but a structural imperative with long-term economic and social consequences. The literature reviewed here underscores that meaningful STEM inclusion for girls of color requires more than access to devices or programs. It requires a sustained, intersectional approach that addresses the cultural, institutional, and interpersonal barriers that limit engagement. This study draws on these theoretical insights to examine how global patterns of digital inequality relate to the lived experiences of girls of color and how interdisciplinary strategies can be designed to support their advancement in STEM.

3. METHODS AND DATA SOURCE

This study uses a secondary data analysis approach to investigate systemic inequalities in digital access and STEM preparedness for girls of color. The central dataset is derived from the 2019 UNICEF report *Bridging the Gender Digital Divide: Challenges and an Urgent Call for Action for Equitable Digital Skills Development*, which aggregates findings from the Multiple Indicator Cluster Surveys and the Demographic and Health Surveys. These instruments collect nationally representative, sex-disaggregated data on digital access, internet use, and skill acquisition across youth populations aged 15 to 24 in over 50 low and middle-income countries. The UNICEF dataset serves as the primary source for the current analysis because of its scope, methodological consistency, and relevance to key Sustainable Development Goals, including indicators 4.4.1, 5.b.1, and 17.8.1. Although the data were collected outside of the United States, the underlying patterns of digital exclusion, particularly those that affect girls from disadvantaged backgrounds, resonate with national research on racial and gender disparities in American STEM education. By applying a comparative lens, the study situates the global experiences of girls in digitally marginalized contexts alongside the systemic barriers faced by girls of color in the United States. This approach is guided by the assertion from Ong *et al.,* (2011) that examining multiple layers of exclusion requires attention to both structural and cultural domains.

The UNICEF report incorporates findings from several independent studies and development agencies, many of which are cited directly in this work as secondary sources. For example, Quisumbing and Maluccio (2000) provided a foundational analysis of intrahousehold resource distribution, demonstrating that family investments in education and technology often favor boys over girls. This insight informs the discussion of within-household disparities in digital skill acquisition. Similarly, the OECD (2018) report on digital inclusion identifies gendered expectations and unequal exposure as central drivers of skill gaps in technology education, even in well-resourced environments. These

and other studies are cited independently to emphasize their contribution to the theoretical and empirical grounding of the analysis. To enhance the accessibility and comparative clarity of the findings, three visual tables from the UNICEF dataset have been adapted and will be presented as figures in later sections. These include:

- Figure 1: Gender parity ratios in internet use across selected countries.
- Figure 2: Percentages of youth with at least one digital skill, disaggregated by sex.
- Figure 3: Digital skill differences within the same household (female versus male youth).

These tables are used not only to illustrate global trends but also to highlight the relevance of these patterns for girls of color in the United States and similar high-income settings. Each figure has been selected based on its alignment with core themes in the literature, including access inequality, skill disparities, and gendered household dynamics. The methodology also draws from critical educational theory to interpret these quantitative findings. Scholars such as Scott *et al.,* (2018) and Ong *et al.,* (2011) argue that intersectionality must be more than a conceptual lens. It should also guide data interpretation and policy response. As such, the analysis foregrounds the specific experiences of girls who are marginalized at multiple levels, in their homes, schools, and broader societal contexts. This approach is critical because traditional metrics such as household connectivity or school enrollment can mask more profound inequalities. For instance, a household may report internet access. However, girls within that household may have no meaningful opportunity to use it due to gendered surveillance, time constraints, or fear of online harassment. These conditions require disaggregated, gender aware analysis that accounts for both statistical representation and lived realities.

The use of pre-2020 data is an intentional decision to emphasize long-standing trends that predate recent disruptions such as the COVID-19 pandemic. While more recent events have exacerbated digital disparities, the structural patterns of exclusion documented in the UNICEF report and supporting literature reveal that these inequities have deep roots. Understanding their persistence across time and geography is essential for developing durable, equity-driven interventions. This method and data framework combine global comparative data with intersectional analysis to investigate how gender, race, and social position shape digital access and STEM readiness. It prepares the ground for a focused discussion of findings that will follow, highlighting both quantitative disparities and their qualitative significance for educational equity.

4. FINDINGS AND ANALYSIS

Access Disparities: Global Patterns and Local Resonance

Access to digital tools is widely considered a foundational step toward educational equity in the twenty-first century. Nevertheless, as the UNICEF (2019) report makes clear, digital access is not evenly distributed across populations, particularly when examined through the lens of gender. For adolescent girls, especially those in low-income and marginalized communities, the internet is often out of reach, not just because of infrastructural deficits but because of systemic gender norms that limit their mobility, autonomy, and control over technology. This section explores global disparities in internet access and their implications for girls of color, both internationally and within the context of the United States. The data show that across most of the 54 countries and territories surveyed, adolescent girls aged 15 to 24 are significantly less likely than their male peers to use the internet. In only eight of these countries has gender parity been achieved, meaning that for the overwhelming majority, digital access remains stratified by sex (UNICEF, 2019). For instance, in Chad, only 15 adolescent girls use the internet for every 100 boys. In Balochistan, Pakistan, the ratio is 18 to 100. These disparities are not simply statistical. They reflect embedded social expectations that shape which youth are seen as entitled to explore digital spaces and which are restricted in the name of tradition, protection, or economic pragmatism.

This pattern is echoed in the United States, albeit in a different form. Research by Rideout and Robb (2019) shows that students from low-income, Black, and Hispanic households are less likely to have consistent high-speed internet access or personal computers at home. Among those who do, the devices are often shared with multiple family members, limiting both time and continuity of use. Girls in these households face additional challenges, such as responsibility for caregiving or household tasks, which reduce their available time for academic and digital engagement. These access gaps place girls of color at a systemic disadvantage in an educational system that increasingly relies on digital tools for instruction, communication, and enrichment. Digital access is also influenced by sociocultural values within the household. Quisumbing and Maluccio (2000) argued that intrahousehold resource distribution often favors boys, particularly in societies where men are expected to be the primary earners. Even in homes with internet access, parents may restrict girls' usage out of concern for safety, moral values, or academic distraction. These restrictions, while often motivated by protective instincts, frequently result in reduced exposure to digital tools and limited opportunities to develop technological fluency.

Moreover, public access points such as libraries and community centers are not equally viable for all youth. Safety concerns, lack of transportation, and

restricted hours often deter girls from accessing these spaces. As a result, their learning opportunities remain confined to what is available and permitted within the home. This limited engagement prevents girls from developing the confidence and autonomy needed to explore digital technologies in a self-directed and empowering manner. In educational settings, these access disparities are compounded by unequal infrastructure. The OECD (2018) notes that schools serving lower-income communities often lack the bandwidth, equipment, or digital curriculum necessary to support robust technology integration. In the United States, such disparities disproportionately affect schools attended by Black and Hispanic students, many of whom are girls. This structural exclusion from digital learning environments limits not only academic achievement but also long-term readiness for STEM fields, where digital fluency is increasingly non-negotiable.

Even in environments where digital devices are present, the quality of use matters significantly. Van Dijk (2006) emphasized that the second level of the digital divide concerns the **use** of technology, not merely whether it is available, but how it is used and for what purposes. Girls of color, particularly in constrained learning environments, are less likely to engage in high-skilled digital tasks such as coding, simulation, or data analysis. Instead, their digital engagement may be confined to basic word processing or passive consumption, activities that do not build the competencies needed for STEM success. The implications of unequal access are long-reaching. Without early and consistent exposure to digital tools, girls of color are less likely to develop an interest in STEM subjects, less likely to participate in enrichment programs, and less likely to envision themselves as future technologists, scientists, or engineers. Access thus becomes more than a technical concern; it becomes a gatekeeper to identity formation, aspiration, and opportunity. To visualize the scope of these disparities, the table below presents selected gender parity ratios in internet use among youth aged 15 to 24 from the UNICEF data. These ratios offer a comparative snapshot of countries where access is either relatively equitable or significantly skewed in favor of boys.

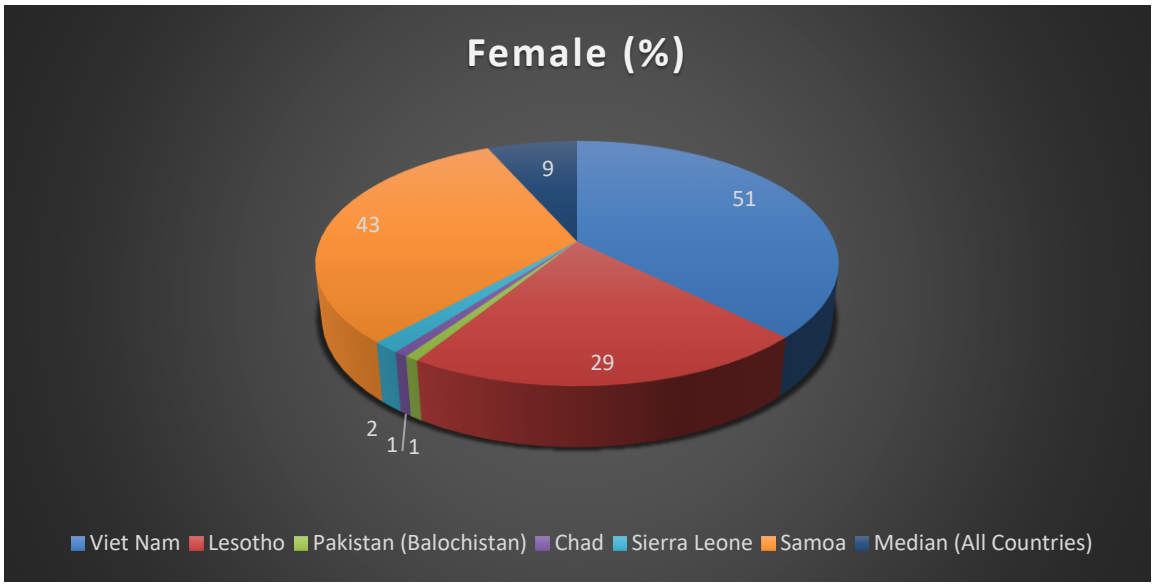

Figure 1: Gender Parity Ratio in Internet Use Among Youth Aged 15 to 24 (Selected Countries)

Skill Acquisition Inequities: The Second Level of Digital Exclusion

Beyond access, the digital divide manifests even more starkly in disparities related to digital skill development. While access to the internet or devices is a prerequisite for digital engagement, it is digital competency that ultimately enables youth to leverage technology for learning, innovation, and economic mobility. This section examines global and comparative data on digital skill acquisition among adolescents. It reveals how gendered norms, educational inequities, and family dynamics limit girls' digital growth, particularly those of color. UNICEF (2019) reports that in the majority of countries surveyed, girls aged 15 to 24 are less likely than boys to report possessing even one basic digital skill. These include tasks such as sending an email with an attachment, copying or moving a file, or installing an application. The median percentage of girls who demonstrated at least one such skill was just 9 percent compared to 20 percent for boys. In several countries, particularly in Sub-Saharan Africa and South Asia, fewer than 5 percent of girls reported having any digital skills at all.

These disparities persist even in contexts where girls outperform boys in basic literacy or school enrollment. For example, in Viet Nam and Lesotho, where gender parity in internet use has been achieved or exceeded, girls still fall behind boys in actual digital competencies (UNICEF, 2019). This suggests that

access, while necessary, does not automatically translate into practical use. It also indicates that broader social and educational structures continue to limit girls' confidence and ability to engage with technology in a meaningful way. This pattern is also observable in high-income countries. Rideout and Robb (2019) found that even when students from low-income and minority communities in the United States have access to devices, they are less likely to use them for skill-building activities such as research, coding, or creative production. Instead, much of their screen time is devoted to passive or recreational consumption. Girls of color, in particular, often lack structured opportunities to develop digital proficiencies that align with academic or career goals. This lack of exposure at an early age results in lower self-efficacy and contributes to the belief that STEM subjects are not "for them." Educational environments play a crucial role in shaping these outcomes. According to the OECD (2018), boys are more likely to be enrolled in courses that involve computer science, robotics, or data analysis, while girls are often channeled into general technology or communication tracks. These curricular divisions reinforce stereotypes about technological aptitude and steer students toward gendered career paths. Even when girls of color express interest in STEM subjects, they may encounter implicit biases from teachers, limited institutional support, or a lack of relatable role models, all of which can dissuade them from persisting in the field (Ong et al., 2011). The literature further emphasizes that digital skills are not acquired in isolation but are deeply influenced by social norms. Van Dijk (2006) argues that skill acquisition is determined by both structural access and motivational factors. Girls may not be encouraged to experiment with digital tools or may feel intimidated in male-dominated technology spaces. Without positive reinforcement and culturally relevant pedagogical approaches, the opportunity to build digital fluency can be lost during critical developmental stages.

Within the home, the gap in digital skill development is often maintained by protective or restrictive parenting. The Web Foundation (2018) notes that adolescent girls face higher risks of online harassment and surveillance, which leads many parents to limit their internet engagement. While these restrictions may be intended to ensure safety, they often have the unintended consequence of reducing digital literacy. This dynamic is particularly concerning for girls of color, who already experience multiple layers of marginalization in both physical and digital spaces. Moreover, digital skills are increasingly seen as necessary for participation in the modern workforce. The United Nations (2018) highlighted that 90 percent of future jobs will require some level of digital competence. Suppose girls of color are not given equal opportunities to develop these skills early on. In that case, they face long-term exclusion from high-growth industries and leadership roles in science and technology. This makes digital skill acquisition not just a matter of educational equity but a question of economic justice.

To underscore the gender gap in digital skills, the following table presents comparative data from selected countries, highlighting the percentage of youth aged 15 to 24 who report having at least one digital skill, disaggregated by sex. The disparities shown here illustrate the structural disadvantages that girls face globally and provide a comparative context for the challenges encountered by girls of color in the United States.

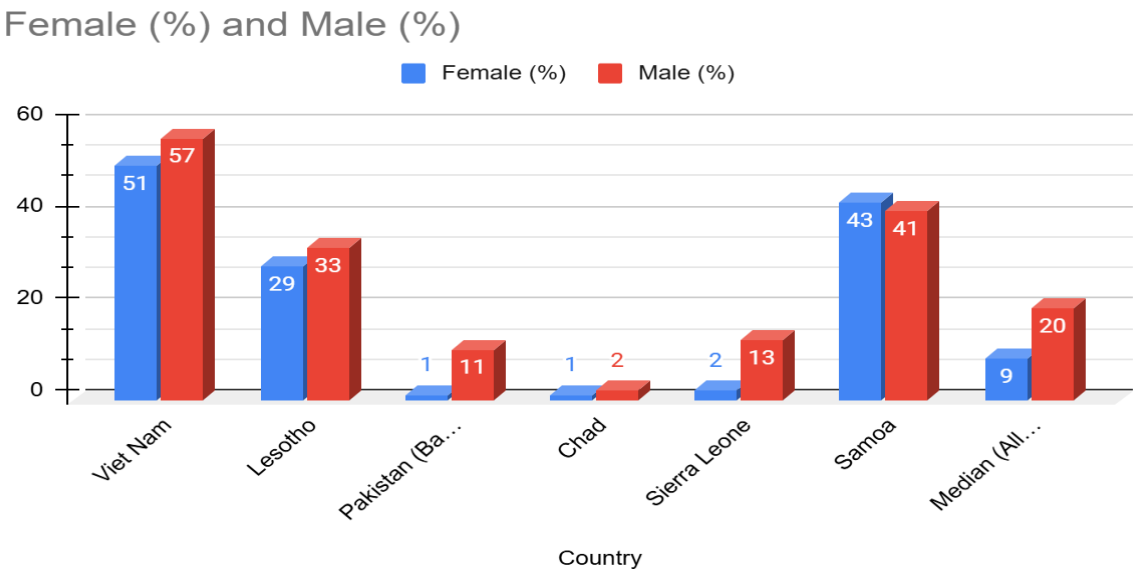

Figure 2: Percentage of Youth (15 to 24) with At Least One Digital Skill by Sex (Selected Countries)

Within-Household Gendered Bias: The Invisible Divide

While national and regional data on digital access and skills help identify broad patterns of exclusion, they often obscure a more subtle but equally powerful barrier that operates within families. Even in households where digital devices and internet access are present, girls and boys do not always benefit equally. This intra-household gender bias plays a critical role in determining how digital resources are distributed and who is empowered to use them. For girls of color, particularly in underserved communities, these bias compounds external structural barriers and further restricts opportunities for STEM engagement. UNICEF (2019) provides clear evidence that digital skills are not distributed equally within households. In a majority of countries surveyed, girls and boys aged 15 to 24 living in the same homes exhibited significant differences in digital skill acquisition. In 22 of 30 countries with comparable data, girls were less likely than their male siblings to possess at least one digital skill. These gaps persisted regardless of household income level or urban location, suggesting that the gendered dynamics at play are rooted in social norms rather than material scarcity.

This phenomenon is consistent with earlier findings by Quisumbing and Maluccio (2000), who documented how gender roles influence family investment in education and training. In many cultures, boys are seen as future earners and are therefore prioritized when it comes to tools perceived as linked to professional advancement, including digital devices. Girls, on the other hand, are more likely to be assigned domestic responsibilities or discouraged from spending unsupervised time online. These restrictions may arise from concerns about safety or propriety but have the unintended effect of limiting digital literacy and, by extension, academic and career potential. In more affluent households, this gender gap may be masked by the presence of multiple devices, but access does not always equate to equitable use. According to van Dijk (2006), digital inequality includes not only technical access but also motivational access, the encouragement, freedom, and support to engage meaningfully with technology. Without parental guidance or positive role models, girls may lack both the time and confidence to develop digital competencies. Even when parents value education, their expectations may unconsciously reflect gendered beliefs about which careers are appropriate or realistic for their daughters.

In the United States, these intra-household dynamics intersect with racial and socioeconomic inequalities in significant ways. Rideout and Robb (2019) found that among low-income families, shared devices are often monopolized by male siblings or adults for work or entertainment purposes. Girls in these homes may be relegated to less favorable times of use or less challenging tasks. Additionally, girls of color are often responsible for caring for younger siblings or helping with household chores, which reduces the time and energy available for exploring educational technology or participating in virtual learning environments. The cultural framing of technology use also affects how girls are supported or monitored. In households where parents are unfamiliar with technology, boys may be given greater freedom to experiment, while girls are more likely to be supervised or restricted. These patterns are reinforced by broader societal narratives that frame technological competence as a male domain. As a result, girls may internalize the belief that they are less capable or less welcome in digital spaces, a perception that can limit their interest in STEM from an early age (Ong *et al.,* 2011).

This intra-household bias also has implications for digital safety. The Web Foundation (2018) notes that girls are more likely to face online harassment, which can lead families to restrict their use of digital tools rather than teach them how to navigate these spaces safely. Such protective limitations, while well-intentioned, may reinforce the idea that girls belong offline or are inherently vulnerable in digital environments. This, in turn, narrows their digital learning experiences and further entrenches disparities in skill development. Notably, the UNICEF data reveal that intra-household gender gaps in digital skills are not exclusive to low-income countries. In several middle-income countries with high overall access rates, girls still lag behind boys in the same household. This suggests that gendered expectations are pervasive and culturally embedded, not merely outcomes of economic constraint. Bridging this divide requires not only material investment but also a shift in social norms, parenting practices, and educational engagement that values girls' digital development as a critical priority. To highlight the significance of this issue, the table below presents selected examples from the UNICEF dataset that show the gender gap in digital skill acquisition among siblings within the same household. Negative values indicate that girls are at a disadvantage compared to boys.

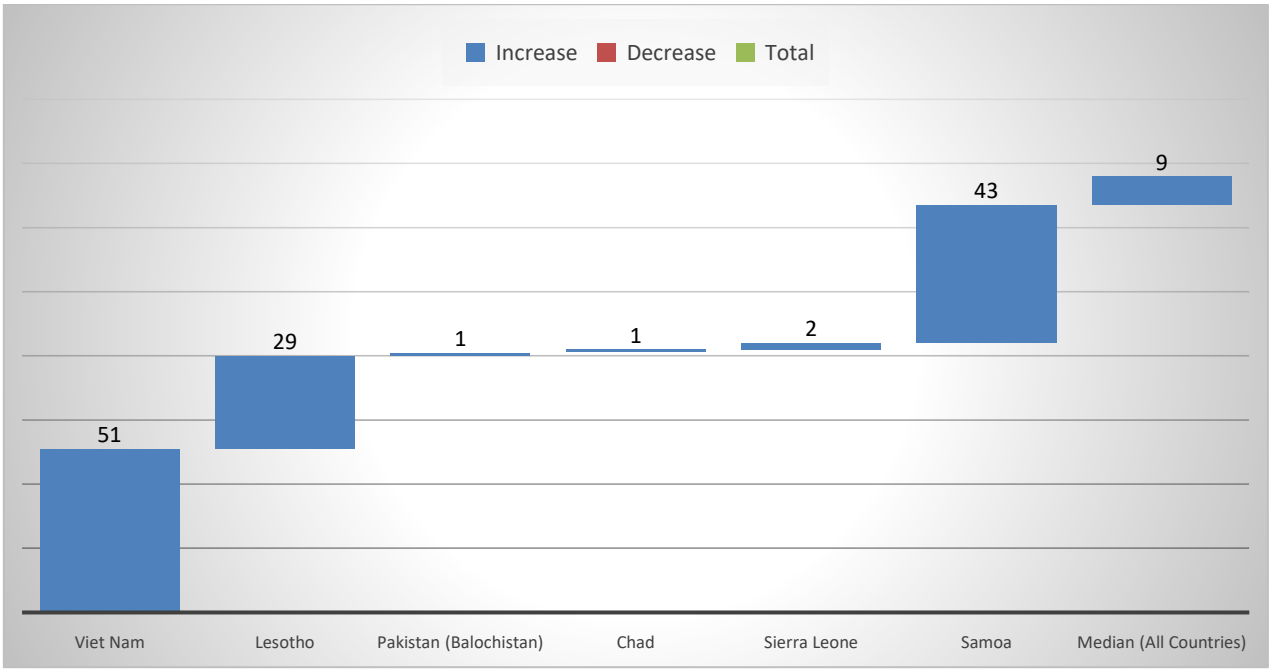

Figure 3: Gender Gap in Digital Skills Within the Same Household (Female – Male Percentage Point Difference)

These figures emphasize that even in environments where digital tools are available, the benefits are not evenly distributed across genders. For girls of color, particularly those navigating intersecting layers of marginalization, this intra-household bias constitutes a critical yet often invisible barrier to full participation in digital learning and future STEM pathways.

5. DISCUSSION

The findings presented across access, skill acquisition, and intra-household disparities provide a multifaceted view of the structural and interpersonal barriers that limit girls of color from fully participating in the digital and STEM landscape. These barriers are not isolated, but rather interdependent, forming a layered system of exclusion that undermines educational equity from both global and local perspectives. By applying an intersectional framework, this analysis makes visible how gendered, racialized, and class-based dynamics collectively shape the educational futures of girls who are already structurally marginalized. Globally, the UNICEF (2019) data reveal a consistent pattern: girls aged 15 to 24 are less likely than boys to access the internet, develop digital skills, or benefit from technological opportunities, even within the same household. These findings affirm van Dijk's (2006) assertion that digital inequality extends beyond infrastructure to include disparities in usage, motivation, and empowerment. For girls of color in the United States, these patterns mirror the realities documented by Rideout and Robb (2019), who show that device sharing, limited home connectivity, and time scarcity disproportionately affect students in low-income and minority households. This similarity across global and national contexts highlights a structural problem that transcends geography and points to systemic gender bias deeply embedded in both policy and practice.

In particular, the intra-household data offer critical insight into the often invisible gender norms that govern digital learning. As Quisumbing and Maluccio (2000) argued, families do not distribute resources in neutral ways. Investments in boys' education and technological literacy are often rationalized by future income potential or perceptions of competency. At the same time, girls' learning is deprioritized due to caregiving roles or concerns about digital safety. This study reinforces that dynamic by showing how even in resource-rich settings, girls may be restricted or discouraged from using digital tools in a way that supports long-term educational growth.

The role of educational institutions is equally significant. Schools, intended to serve as equalizers of opportunity, frequently reflect and reinforce social biases. The OECD (2018) reports that technology instruction is often stratified along gender lines, with boys more likely to be introduced to advanced digital tasks while girls are directed toward communication or design-oriented uses. Within the United States, these patterns are exacerbated for girls of color, who must contend with the intersection of implicit racial bias, a lack of culturally responsive teaching, and minimal representation in STEM curricula (Ong *et al.,* 2011). Without intentional efforts to support their inclusion, many girls of color disengage from STEM fields not because of a lack of ability, but because they do not see themselves reflected, welcomed, or encouraged. Safety concerns and societal narratives also restrict girls' digital development. The Web Foundation (2018) observed that online harassment and the fear of exposure have led

many caregivers to limit girls' access to digital spaces. While this restriction is often intended to protect, it also serves to control, keeping girls offline during critical developmental years and limiting their ability to build confidence in digital environments. This constraint is particularly damaging when coupled with broader cultural narratives that position technology as a male-dominated space. As van Dijk (2006) noted, motivation is a key factor in the development of digital skills, and experiences of exclusion and fear can deeply erode that motivation.

The implications for STEM readiness are profound. As the United Nations (2018) predicted, digital fluency will be essential for participation in nearly all sectors of the economy. Girls who are denied early exposure to digital tools or who do not receive reinforcement from home and school are less likely to enroll in advanced STEM coursework or pursue technology-related careers. The loss is not only personal but societal. Failing to support the inclusion of girls of color in STEM fields limits innovation, narrows the talent pipeline, and perpetuates inequality. However, this analysis also reveals where interventions can be most effective. The patterns of exclusion are systemic but not immutable. Schools that adopt culturally responsive pedagogies can affirm the identities and aspirations of girls of color. Community programs that provide mentorship and safe access to digital tools can fill gaps left by under-resourced homes and schools. Families that are educated on the importance of equitable digital use can shift internal dynamics and support girls' learning more intentionally. Finally, policies that prioritize intersectional data collection and accountability can ensure that digital inclusion efforts do not overlook those most in need of support.

The findings discussed here point not just to a technological gap but to a justice gap. If equity in digital education is to be achieved, then solutions must be built on a foundation of intersectionality, cultural awareness, and sustained institutional commitment. Girls of color are not inherently excluded from digital spaces. Instead, they are navigating environments that have not been designed with their success in mind. Changing that requires a shift in both perspective and practice, one that moves beyond inclusion as a goal and toward equity as a standard.

6. RECOMMENDATIONS

The disparities identified in this study call for targeted, intersectional, and interdisciplinary strategies that respond to both the structural and interpersonal barriers faced by girls of color in accessing STEM opportunities. These recommendations draw on the findings from global and national data and are grounded in the belief that equity in education requires more than equal access; it demands systemic transformation that centers the realities and aspirations of the most marginalized.

First, schools must adopt culturally responsive pedagogical practices that validate the identities of girls of color and actively counter the exclusionary norms often present in STEM classrooms. As Scott *et al.,* (2018) emphasized, inclusion must go beyond the curriculum to encompass school climate, teacher training, and student support systems. Educators should receive training not only in technical content but also in cultural competency, enabling them to create classroom environments where all students feel seen, valued, and empowered to succeed in STEM. Second, families and caregivers must be engaged as partners in digital and STEM education. Quisumbing and Maluccio (2000) illustrated how intrahousehold gender norms affect educational investments. Awareness campaigns and community-based workshops can help parents understand the importance of equitable digital access, encourage supportive technology use at home, and address safety concerns in a proactive rather than restrictive manner. When caregivers are informed and invested, they become powerful advocates for their daughters' technological development. Third, access to out-of-school enrichment opportunities must be expanded, particularly in under-resourced communities. After-school programs, community centers, and libraries can serve as vital access points for girls who may not receive adequate digital engagement in school or at home. These programs should prioritize mentorship by women of color in STEM fields, offering girls not only exposure to digital tools but also the opportunity to envision themselves as future scientists, engineers, and innovators. Ong *et al.,* (2011) noted that such mentorship is key to building persistence and identity in STEM trajectories. Fourth, digital inclusion efforts must be grounded in comprehensive policy frameworks that prioritize intersectional data collection and accountability. Policymakers should require the disaggregation of digital access and skill data by both gender and race to ensure that interventions are effectively reaching girls of color. As UNICEF (2019) and the OECD (2018) both suggest, equitable technology policy must be responsive to local contexts while informed by global trends. Investments in infrastructure must be matched with investments in training, curriculum reform, and community engagement.

Finally, digital safety education must be an integral part of any initiative. The Web Foundation (2018) reported that fear of online harassment remains a significant barrier to girls' full participation in digital spaces. Rather than limiting access as a response to risk, schools and communities should equip girls with the skills to navigate online environments confidently and securely. Digital rights education, awareness of online privacy, and strategies for managing cyberbullying are essential components of digital literacy for girls of color. These recommendations form a cohesive strategy for addressing the inequities identified in this study. By centering girls of color and applying both intersectional and interdisciplinary perspectives, these interventions

can begin to shift educational outcomes and create more just, inclusive pathways into STEM.

7. CONCLUSION

This study has examined how digital inequity, when viewed through the lens of intersectionality, reveals a deeply rooted system of exclusion that limits opportunities for girls of color in STEM education. Drawing from global data presented by UNICEF (2019) and supported by foundational scholarship in gender, education, and technology, the analysis demonstrates that digital access alone is insufficient to bridge existing divides. Instead, systemic disparities in digital skills, resource distribution within households, and educational experiences continue to shape unequal learning outcomes across racial, gendered, and socioeconomic lines. The global findings outlined in this research show that girls in many low and middle-income countries remain significantly behind boys in both internet access and digital skill acquisition. These disparities are echoed in high-income contexts such as the United States, where girls of color experience disproportionate barriers related to income, household responsibilities, shared device use, and a lack of culturally responsive pedagogy. The work of Rideout and Robb (2019), Ong *et al.,* (2011), and Scott *et al.,* (2018) all underscore that these barriers are not circumstantial but structural. They are embedded in the ways schools are organized, how families navigate resources, and how society conceptualizes technology as a male domain.

Within the household, gendered patterns of digital exclusion are persistent and significant. Quisumbing and Maluccio (2000) highlighted how family resource allocation often favors boys, a finding supported in UNICEF (2019) data that reveal within-home disparities in digital skill levels. These patterns are driven by cultural expectations that assign different roles and futures to sons and daughters. Girls, particularly in low-income families and communities of color, are frequently expected to take on caregiving roles or are more heavily monitored in their use of digital technology. This results in less time, freedom, and encouragement to develop critical digital competencies. The importance of digital skill acquisition cannot be overstated. As van Dijk (2006) and the United Nations (2018) make clear, digital literacy has become a prerequisite for full participation in education, employment, and civic life. Without focused interventions, the digital divide threatens to reinforce broader cycles of inequality and underrepresentation in STEM fields. When girls of color are excluded from foundational digital experiences during their formative years, they are systematically denied access to the pathways that lead to high-paying, future-ready careers.

However, the findings also reveal areas for actionable change. Schools, families, communities, and policymakers each have a role to play in transforming the current landscape. Culturally responsive teaching, equitable resource allocation within homes, inclusive mentorship programs, and policies informed by intersectional data are all key components of this shift. Importantly, these interventions must not be isolated or short-term. Lasting change requires an integrated strategy that acknowledges the complex realities faced by girls of color and responds with sustained, equity-driven investment. Advancing STEM opportunities for girls of color demands more than bridging technical gaps. It requires the dismantling of structural barriers and the cultivation of environments where girls can build skills, confidence, and a sense of belonging. This is not only a matter of inclusion. It is a matter of justice. Suppose society is to move toward a truly equitable digital future. In that case, the full participation of girls of color must not be treated as an afterthought but as a foundational priority.

REFERENCES

- Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, *1989*(1), Article 8.
- Gakidou, E., Cowling, K., Lozano, R., & Murray, C. J. (2010). Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: A systematic analysis. *The Lancet*, *376*(9745), 959–974. https://doi.org/10.1016/S0140-6736(10)61257-3
- OECD. (2018). *Bridging the digital gender divide: Include, upskill, innovate*. OECD Publishing. https://www.oecd.org/digital/bridging-the-digital-gender-divide.pdf
- Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in STEM. *Harvard Educational Review*, *81*(2), 172–209. https://doi.org/10.17763/haer.81.2.t022245n7x4752v2
- Quisumbing, A. R., & Maluccio, J. A. (2000). Intrahousehold allocation and gender relations: New empirical evidence. *The World Bank Economic Review*, *14*(1), 1–29. https://doi.org/10.1093/wber/14.1.1
- Rideout, V., & Robb, M. B. (2019). *The Common Sense census: Media use by tweens and teens*. Common Sense Media. https://www.commonsensemedia.org/research/the-common-sense-census-media-use-by-tweens-and-teens-2019
- Scott, A., Sheridan, K., & Clark, K. (2018). Culturally responsive computing: A theory revisited. *Learning, Media and Technology*, *39*(4), 412–436. https://doi.org/10.1080/17439884.2014.924966
- UNESCO. (2018). *A lifeline to learning: Leveraging mobile technology to support education for refugees*.

https://unesdoc.unesco.org/ark:/48223/pf0000261278

- UNICEF. (2019). *Bridging the gender digital divide: Challenges and an urgent call for action for equitable digital skills development*. https://www.unicef.org/reports/bridging-gender-digital-divide
- United Nations. (2018). *The impact of digital technologies on gender equality in developing countries*. https://unctad.org/system/files/official-document/ecn162018d2_en.pdf
- van Dijk, J. (2006). Digital divide research, achievements and shortcomings. *Poetics*, *34*(4-5), 221–235. https://doi.org/10.1016/j.poetic.2006.05.004
- Web Foundation. (2018). *Women's rights online: Digital gender gap audit scorecard*. https://webfoundation.org/research/digital-gender-gap-audit-scorecard/
- World Bank. (2018). *World Development Report 2018: Learning to realize education's promise*. https://www.worldbank.org/en/publication/wdr2018