



Teacher Perceptions of Pedagogical Barriers Across Traditional and Digital Contexts: A Mixed-Methods Analysis

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Abstract—The increasing integration of digital technologies into K–12 education has transformed teaching practices while introducing new pedagogical challenges. This study comparatively examines teachers’ perceived barriers in traditional and digital teaching contexts and identifies how the nature and prevalence of these barriers change across instructional environments. A mixed-methods design was employed with 50 K–12 teachers from urban, suburban, and rural schools in the United States. Data were collected through semi-structured interviews and Likert-scale surveys and analyzed using thematic analysis and descriptive statistics. Eight major barriers were identified. In traditional teaching, classroom management was the most prevalent challenge (84%), followed by resource scarcity (78%), student diversity and differentiation (70%), and parental communication (56%). In digital teaching, the digital divide emerged as the most widespread barrier (94%), followed by virtual student engagement (90%), technological literacy (82%), and work-life balance (76%). Overall, digital barriers were reported more consistently across participants than traditional barriers, indicating that the transition to technology-mediated instruction shifts pedagogical difficulties from predominantly classroom- and resource-related issues toward infrastructural, technological, engagement, and workload-related challenges. These findings demonstrate the need for context-specific teacher support strategies that combine digital infrastructure investment, targeted technology training, engagement-oriented pedagogical development, and measures to protect teacher well-being.

Keywords—Digital Pedagogy, Teacher Barriers, Educational Technology, Mixed-Methods, K-12 Education

1. INTRODUCTION

The landscape of K-12 education is undergoing a profound transformation, largely driven by the pervasive influence of digital technology [1][2]. This shift, accelerated by the global pandemic, has compelled educational systems worldwide to reconsider traditional pedagogical models and embrace digital alternatives. While the potential of educational technology (EdTech) to enhance learning is widely acknowledged, its rapid and often mandated adoption

has surfaced a complex array of challenges for frontline educators. Teachers, as the primary facilitators of learning, are navigating a dual reality, balancing the demands of conventional classroom instruction with the complexities of digital and hybrid models.

A significant body of research has separately explored the difficulties inherent in traditional teaching, such as classroom management and resource scarcity, and the novel obstacles presented by digital education, including the digital divide and the need for new pedagogical skills. However, there is a conspicuous gap in the literature regarding a direct, comparative analysis of these barriers from the perspective of teachers who operate across both domains. Understanding how these challenges manifest, differ, and intersect is crucial for developing effective support systems and fostering resilient and adaptive teaching practices.

This study aims to address this gap by systematically identifying and comparing the barriers perceived by K-12 teachers in both traditional and digital teaching contexts. Through a mixed-methods approach, we seek to provide a nuanced, evidence-based account of the contemporary pedagogical landscape, ultimately informing the design of more equitable and effective educational futures. This paper will first review the existing literature on teaching barriers, then detail the methodology employed, present the comparative findings, and finally, discuss the implications of these findings for policy, practice, and future research.

Accordingly, this study examines how the same purposively recruited K–12 teachers described barriers across traditional and digital teaching contexts. It addresses three research questions: RQ1: What teacher-perceived pedagogical barriers are reported in traditional teaching contexts? RQ2: What teacher-perceived pedagogical barriers are reported in digital teaching contexts? RQ3: Within this sample, how do the reported prevalence patterns of barriers differ across the two contexts? The study is exploratory and descriptive; it does not test demographic subgroup differences or population-level hypotheses.

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2. RELATED WORK

The challenges faced by educators are a long-standing area of academic inquiry. Research into traditional teaching environments has consistently identified several key barriers. Classroom management, including student behavior and engagement, remains a primary concern, particularly for early-career teachers [3]. Furthermore, the increasing diversity in student populations, encompassing varied learning needs, cultural backgrounds, and socioeconomic statuses, presents a significant pedagogical challenge that demands differentiated instruction and inclusive practices [4]. Systemic issues such as inadequate resources, limited funding, and high-stakes testing pressures further compound the complexities of traditional teaching [5].

In parallel, the burgeoning field of digital education has its own distinct set of obstacles. The most prominent of these is the digital divide, a multifaceted issue that includes disparities in access to devices and reliable internet, as well as the varying levels of digital literacy among both students and teachers [6]. The transition to online learning also necessitates a fundamental shift in pedagogy, moving from teacher-centered instruction to more student-centered, technology-mediated approaches, a transition for which many educators feel unprepared [7]. Moreover, fostering student engagement and motivation in a remote setting, where the social dynamics of a physical classroom are absent, has proven to be a persistent and difficult challenge [8]. The landscape of K–12 education has undergone substantial transformation with the increasing integration of digital technologies. This transition was accelerated by the COVID-19 pandemic, which disrupted conventional schooling worldwide and forced educational systems to rapidly adopt remote and technology-mediated forms of instruction [9].

While these two bodies of literature provide valuable insights into their respective domains, a comparative perspective is largely absent. Most studies focus on either the traditional or the digital context in isolation. This study builds upon and integrates these separate streams of research by employing a mixed-methods design to directly compare the barriers perceived by teachers across both traditional and digital settings, thereby offering a more holistic and integrated understanding of the challenges confronting contemporary educators.

3. METHODS

To investigate the pedagogical barriers in traditional and digital teaching, this study employed a mixed-methods research design, combining qualitative thematic analysis with quantitative descriptive statistics. This approach allows for a comprehensive understanding of the phenomenon, capturing both the richness of teachers' lived experiences and the broader patterns across the sample.

3.1. Participants and Data Collection

The study involved a purposive sample of 50 K-12 teachers from a variety of school settings (urban, suburban, and rural; public and private) across the United States. Participants were recruited through professional networks, educational associations, and online forums dedicated to teacher professional development. The sample was diverse in terms of teaching experience, grade level, subject area, and geographic location. Each participant engaged in a semi-structured interview lasting approximately 60 minutes. The

interviews were conducted via video conferencing and focused on teachers' experiences with and perceptions of barriers in both their traditional classroom settings and their digital or remote teaching environments. The interview protocol included open-ended questions designed to elicit detailed narratives about specific challenges, coping strategies, and contextual factors influencing the teaching experience.

In addition to the interviews, participants completed a short demographic survey that collected information on years of teaching experience, grade level, subject area, school type, and geographic location. The survey also included Likert-scale questions (ranging from 1 = not a barrier to 5 = significant barrier) for rating the severity of various pre-identified potential barriers in both traditional and digital contexts. This combination of qualitative and quantitative data collection allowed for triangulation and provided both depth and breadth of understanding.

3.2. Data Analysis

All interviews were audio-recorded with participant consent, transcribed verbatim, and anonymized using participant codes (P1, P2, etc.). The qualitative data were analyzed using a thematic analysis approach, following the six-phase process outlined by Braun and Clarke [10]. The research team collaboratively developed a coding framework based on an initial reading of a subset of transcripts, which was then systematically applied to the entire dataset using qualitative analysis software. Themes were identified, reviewed, and refined through an iterative process to ensure they accurately reflected the participants' experiences and captured the nuances of their narratives.

The quantitative data from the survey were analyzed using descriptive statistics to summarize the demographic characteristics of the sample and to provide a quantitative overview of the perceived severity of different barriers. Frequency distributions and percentages were calculated for categorical variables, while means and standard deviations were computed for Likert-scale responses. The qualitative and quantitative findings were then integrated to provide a convergent and more complete picture of the research questions, with qualitative themes supported by quantitative prevalence data.

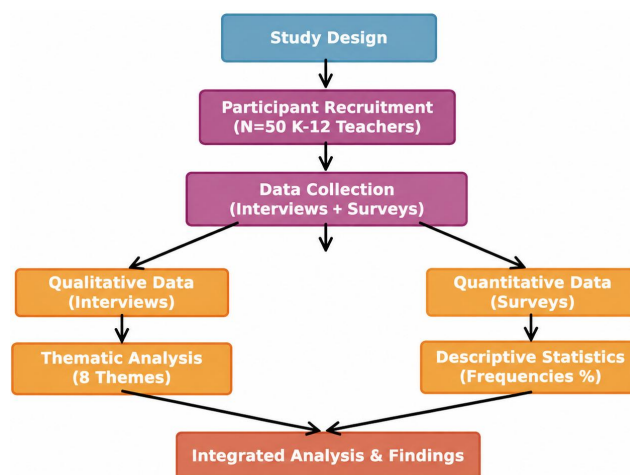


Figure 1. Research Methodology Flowchart

Figure 1 illustrates the complete research workflow, from study design and participant recruitment through data collection (interviews and surveys) to parallel qualitative and

quantitative analysis pathways, culminating in integrated findings. The mixed-methods approach ensures both depth of understanding through thematic analysis and breadth through descriptive statistics.

4. RESULTS

The analysis of interview and survey data revealed a clear distinction between the primary barriers in traditional and digital teaching contexts. This section presents these findings, beginning with the demographic profile of the participants, followed by a thematic exploration of the barriers in each context, supported by illustrative quotes and descriptive statistics.

TABLE I. PARTICIPANT DEMOGRAPHICS (N=50)

Characteristic	Category	N	%
Teaching Experience	1-5 years	15	30%
	6-10 years	20	40%
	>10 years	15	30%
Grade Level	Elementary (K-5)	18	36%
	Middle (6-8)	17	34%
	High (9-12)	15	30%
School Type	Public	40	80%
	Private	10	20%
Geographic Location	Urban	22	44%
	Suburban	18	36%
	Rural	10	20%

4.1. Participant Demographics

The demographic characteristics of the 50 participating teachers are summarized in Table 1. The sample was intentionally diverse, representing a range of experiences, school settings, and locations to capture a breadth of perspectives. The majority of participants (40%) had between 6 and 10 years of teaching experience, with roughly equal representation of early-career (1-5 years) and veteran (>10 years) teachers. Grade level representation was relatively

balanced, with slightly more elementary teachers (36%) than middle or high school teachers. The sample was predominantly from public schools (80%) and included substantial representation from urban (44%), suburban (36%), and rural (20%) settings.

4.2. Thematic Analysis of Barriers

Thematic analysis of the interview data identified eight distinct barriers, organized into two domains: Traditional Teaching Barriers and Digital Teaching Barriers. Table 2 provides an overview of these themes, their definitions, illustrative quotes, and their frequency across the sample. The barriers in the traditional context were experienced by 56% to 84% of participants, while those in the digital context were more universally experienced, affecting 76% to 94% of the sample.

The bar chart directly compares the prevalence of barriers in traditional versus digital teaching environments. Digital teaching barriers are consistently more prevalent, with the digital divide affecting 94% of participants compared to classroom management (84%) in traditional settings. This visualization underscores the heightened challenges posed by rapid digital education adoption.

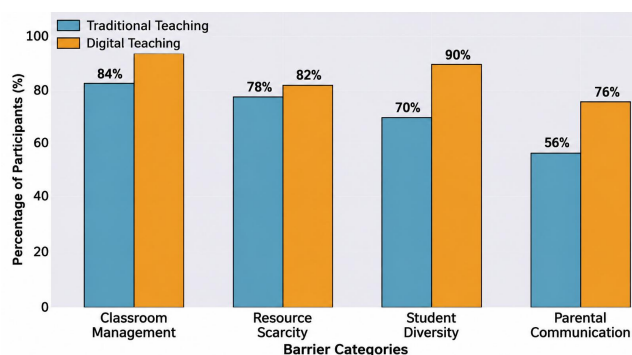


Figure 2. Comparison of Barrier Prevalence Across Teaching Contexts

TABLE II. THEMATIC OVERVIEW OF PEDAGOGICAL BARRIERS

Domain	Theme	Definition	Example Quote	N (%)
Traditional Barriers	1. Classroom Management	Difficulties in managing student behavior and maintaining a productive learning environment.	"You spend half your time just getting them to settle down... it's a constant battle." [P28, High School, Urban]	42 (84%)
	2. Resource Scarcity	Insufficient funding for supplies, outdated technology, and lack of institutional support.	"I have 30 students and only 20 textbooks... I spend my own money on so much." [P11, Elementary, Suburban]	39 (78%)
	3. Student Diversity & Differentiation	Challenges in meeting the varied academic, social, and emotional needs of all students.	"Differentiating for everyone is practically impossible without more support." [P45, Middle School, Urban]	35 (70%)
	4. Parental Communication	Difficulties in managing communication, expectations, and involvement with students' parents.	"Some parents are constantly emailing, others you can never reach. It's a huge drain." [P07, Elementary, Rural]	28 (56%)
Digital Barriers	1. The Digital Divide	Disparities in student access to reliable internet, appropriate devices, and a quiet learning space.	"It means nothing if half my students can't log on because their internet is too slow." [P19, Middle School, Rural]	47 (94%)
	2. Technological Literacy	Lack of adequate training and skills for both teachers and students to effectively use digital tools.	"They gave us the laptops and said 'go', but I had no idea how to use the software." [P33, High School, Suburban]	41 (82%)
	3. Virtual Student Engagement	Difficulties in capturing and sustaining student attention, motivation, and participation in a remote setting.	"It's like teaching into a void. Cameras are off, no one responds... you have no idea if they're learning." [P21, High School, Urban]	45 (90%)
	4. Work-Life Balance	The blurring of boundaries between professional and personal life, leading to increased workload and burnout.	"I was answering emails at 10 PM. The work never stopped. I was completely exhausted." [P15, Elementary, Suburban]	38 (76%)

4.3. Traditional Teaching Barriers

In the traditional classroom setting, four primary themes emerged as significant barriers that teachers consistently encountered in their daily practice. (Figure 3)

4.3.1. Classroom Management and Student Behavior

The most frequently cited challenge was Classroom Management and Student Behavior, experienced by 84% of participants. Teachers described the constant effort required to manage disruptive behavior, maintain focus, and create a productive learning environment. This barrier was particularly acute in urban and under-resourced schools. One high school teacher noted, “You spend half your time just getting them to settle down... it’s a constant battle that drains your energy for actual teaching.” Another elementary teacher elaborated, “When you have 30 kids and only one of you, managing behavior becomes the primary job, not actually teaching content.” The challenge extended beyond simple discipline; teachers described the emotional labor of maintaining patience and consistency while managing diverse behavioral needs.

4.3.2. Lack of Resources and Institutional Support

The second major barrier was Lack of Resources and Institutional Support, reported by 78% of participants. Teachers felt hampered by insufficient funding for essential supplies, outdated technology, and a perceived lack of administrative support. An elementary teacher shared, “I have 30 students and only 20 textbooks that are falling apart. I spend my own money on so much, and the administration just tells you to ‘make do’.” This barrier was particularly pronounced in rural and economically disadvantaged areas. Teachers reported purchasing classroom supplies out of pocket, using outdated materials, and lacking access to technology that could enhance instruction. One middle school

teacher stated, “We don’t have enough computers for a computer lab, we don’t have updated science equipment, and when something breaks, it takes months to get it fixed.”

4.3.3. Student Diversity and Differentiation

Student Diversity and Differentiation emerged as a significant barrier for 70% of participants. Meeting the diverse needs of all students in a single classroom was a major source of stress and frustration. This included accommodating students with learning disabilities, English language learners, and those from different socioeconomic backgrounds. A middle school teacher explained, “In one class, I have students reading at a college level and others at a third-grade level. Differentiating for everyone is practically impossible without more support.” Teachers described the challenge of designing lessons that were neither too easy nor too difficult, and of providing individualized attention within the constraints of large class sizes and limited support personnel. One high school teacher noted, “I want to meet each student where they are, but with 150 students across five classes, it’s just not realistic.”

4.3.4. Parental Communication and Involvement

Parental Communication and Involvement was cited as a barrier by 56% of participants. While parental involvement is often seen as a positive factor, teachers also described challenges in managing communication, dealing with unrealistic expectations, and engaging with parents who were either uncooperative or entirely absent. One elementary teacher stated, “Some parents are constantly emailing, others you can never reach. It’s a huge drain.” Teachers described the emotional labor of navigating complex parent-teacher relationships, managing conflicts, and balancing the need for parental support with professional boundaries.



Figure 3. The Challenges of Traditional Teaching

4.4. Digital Teaching Barriers

When the context shifted to digital teaching, a different and, in many ways, more pervasive set of barriers became prominent. Notably, all digital barriers were experienced by higher percentages of the sample compared to traditional barriers.

4.4.1. The Digital Divide

The most universally experienced barrier was The Digital Divide, affecting 94% of participants. This barrier encompassed students’ lack of access to reliable internet connectivity, appropriate devices, and quiet learning spaces at home. A rural teacher stated, “I can plan the best lesson in the world, but it means nothing if half my students can’t log on

because their internet is too slow or they're sharing one phone with three siblings." Teachers described the frustration of designing engaging digital lessons only to have them rendered inaccessible to a significant portion of their students. One urban teacher noted, "Some of my students live in apartments where there's no WiFi, and their families can't afford home internet. They're trying to do schoolwork on their phones." The digital divide was not merely a technical issue; it was a profound equity problem that exacerbated existing educational inequalities.

4.4.2. Technological Literacy

Technological Literacy was a barrier for 82% of participants, encompassing both teacher and student skill gaps. Many teachers felt thrown into digital teaching with inadequate training or preparation. They struggled with new platforms, software, and pedagogical approaches. One high school teacher shared, "They gave us the laptops and said 'g', but I had no idea how to use the software. I was learning alongside my students, which is not ideal." Teachers also noted the wide variation in students' ability to navigate the digital learning environment independently. A middle school teacher explained, "Some students are tech-savvy, but others don't know how to attach a file or use basic functions. I end up spending a lot of time on technical support instead of teaching."

4.4.3. Virtual Student Engagement and Motivation

Virtual Student Engagement and Motivation emerged as a barrier for 90% of participants. Keeping students focused and engaged in a remote setting was a universal struggle. Teachers described the challenge of capturing attention through a screen and maintaining the social dynamics that are inherent to in-

person learning. One high school teacher lamented, "It's like teaching into a void. Cameras are off, no one responds in the chat... you have no idea if they're learning or watching Netflix." Another elementary teacher noted, "In person, you can see when a kid is confused or bored. Online, they could be doing anything. The engagement just isn't there." Teachers described the difficulty of building relationships, reading nonverbal cues, and maintaining the sense of community that characterizes effective classrooms.

4.4.4. Work-Life Balance and Teacher Burnout

Work-Life Balance and Teacher Burnout was cited by 76% of participants. The boundaries between work and home blurred in the digital context, leading to increased workload and emotional exhaustion. Teachers reported working longer hours, being constantly available to students and parents, and feeling unable to truly disconnect from work. One elementary teacher stated, "I was answering emails at 10 PM. The work never stopped. I was completely exhausted." A high school teacher added, "When your office is in your home, you never really leave work. It's always there, staring at you." Teachers described the psychological toll of the pandemic-era teaching experience, with many reporting symptoms of burnout, anxiety, and depression.

As shown in Figure 4, the heatmap reveals important demographic variations in barrier severity (1-5 scale). Rural teachers face the most severe digital divide (4.9), while urban teachers report higher classroom management challenges (4.3). The visualization demonstrates that barriers are not uniformly experienced across all teacher populations, suggesting the need for targeted, context-specific interventions.

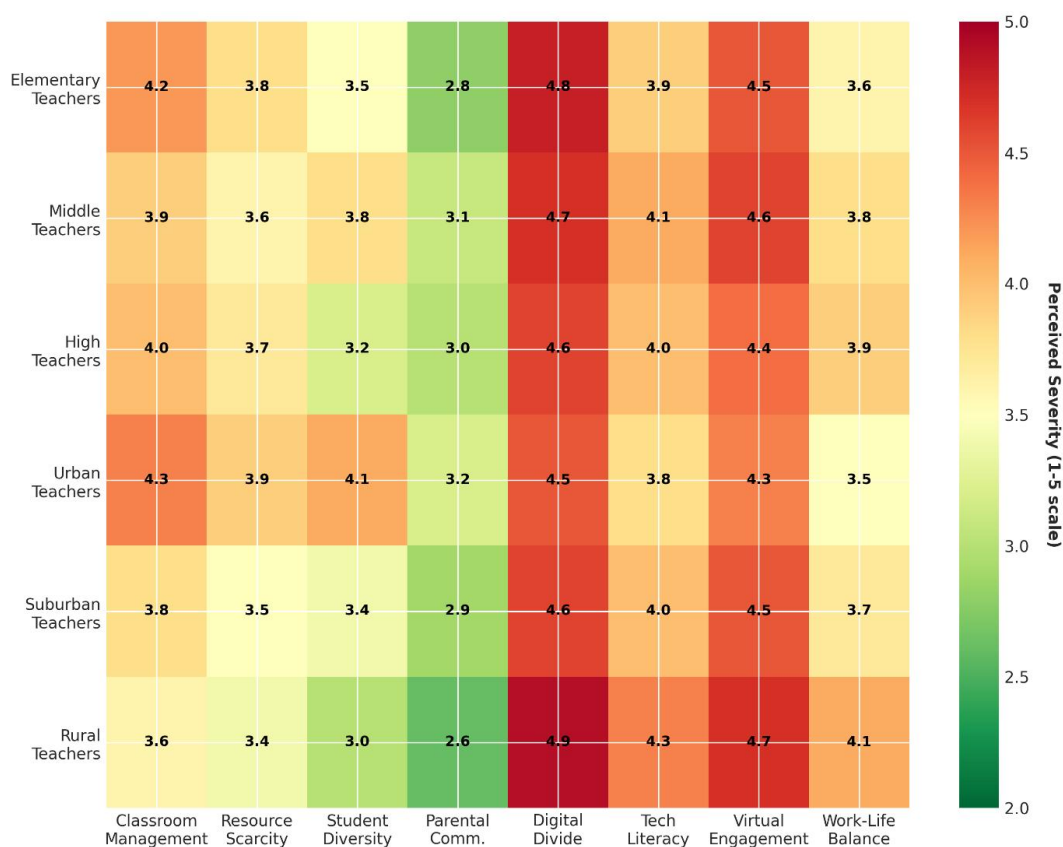


Figure 4. Heatmap of Barrier Severity Across Teacher Groups

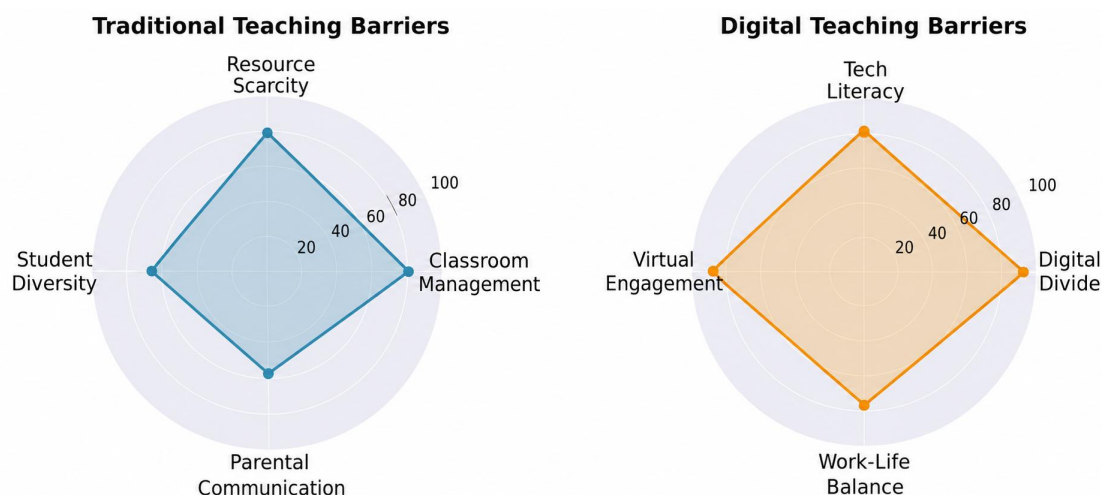


Figure 5. Radar Chart Comparison of Barrier Profiles

Figure 5 provide a striking visual comparison of the barrier profiles in traditional versus digital contexts. The traditional teaching profile shows a more balanced distribution of barriers (56%-84%), while the digital teaching profile reveals a consistently high and concentrated pattern of barriers (76%-94%), with the digital divide and virtual engagement challenges being particularly acute.

As shown in Figure 6, this stratified analysis reveals that early-career teachers (1-5 years) experience the highest burden of digital barriers (88%), while veteran teachers (>10 years) report relatively lower barrier prevalence (68%-79%). However, all experience levels face substantial barriers in both contexts, indicating that experience alone is not a sufficient buffer against contemporary pedagogical challenges.

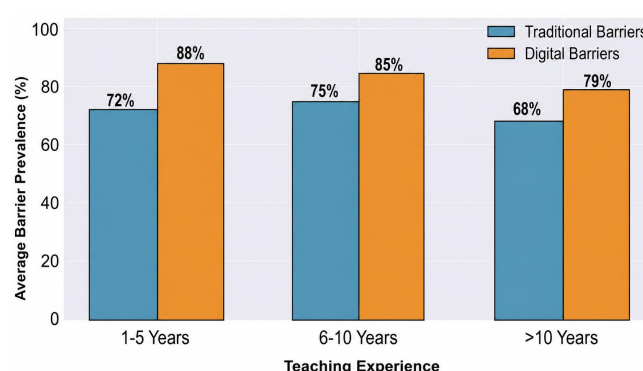


Figure 6. Barrier Prevalence by Teaching Experience Level

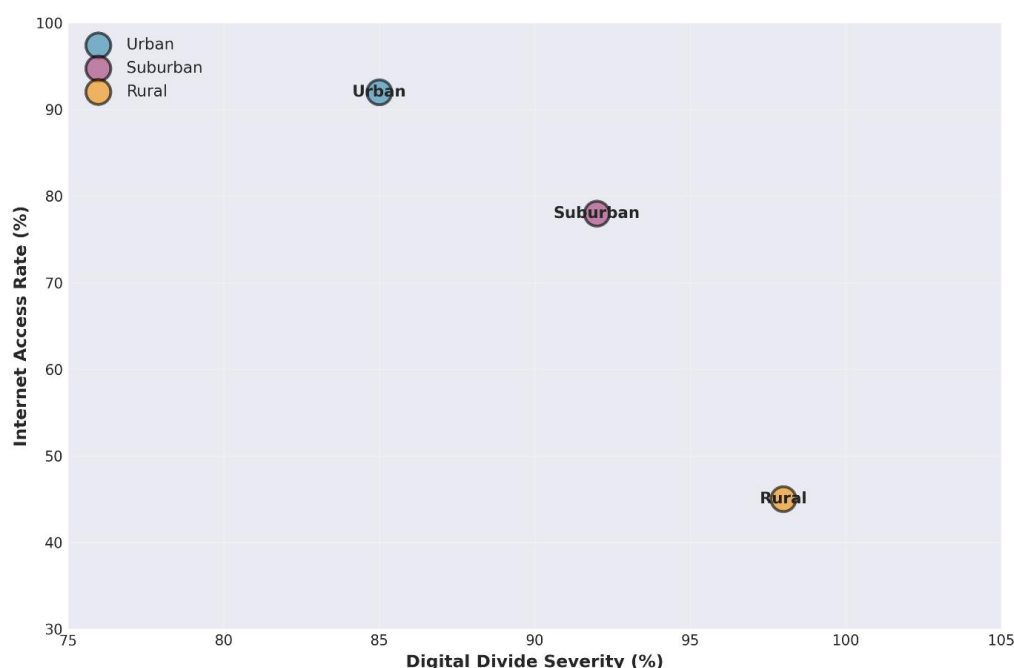


Figure 7. Geographic Location and Digital Divide Relationship

Figure 7 illustrates the stark geographic disparities in digital access and the digital divide severity. Rural areas face the most severe digital divide (98%) with only 45% internet access rate, while urban areas show 85% digital divide

severity but 92% internet access. This visualization underscores the critical need for infrastructure investment in underserved regions.

5. DISCUSSION

5.1. *Duality and Transformation of Teaching Barriers*

The findings of this study highlight a critical duality in the challenges facing modern educators. While the ultimate goal of teaching remains the same—to facilitate learning and foster student development—the barriers to achieving that goal shift significantly with the pedagogical context. The struggles of the traditional classroom are largely interpersonal and resource-based, rooted in the physical co-presence of a diverse group of individuals within a constrained institutional system. In contrast, the barriers in the digital realm are predominantly technological and infrastructural, stemming from issues of access, literacy, and the inherent difficulties of replicating human connection through a screen.

This study's comparative approach extends the existing literature by demonstrating that digital technology does not simply solve old problems; it creates new ones. For instance, while digital tools can offer novel ways to differentiate instruction and provide personalized learning pathways, they are rendered ineffective by the digital divide. A sophisticated adaptive learning platform is useless to a student without reliable internet access or an appropriate device. Similarly, while the issue of physical classroom management may recede in a remote setting, it is replaced by the even more complex challenge of securing and sustaining student engagement in a virtual space, where the teacher's presence is mediated by technology and the informal social dynamics of a classroom are absent.

5.2. *Strategic Interventions and Socio-Technical Solutions*

These findings also highlight the importance of sustained, practice-oriented professional development. Prior evidence suggests that structured teacher coaching can improve instructional practice and student achievement [11], indicating that professional support should extend beyond one-time technology training toward continuous coaching and pedagogical development. A one-size-fits-all approach is unlikely to be effective. Instead, schools and districts must develop a dual strategy, providing resources and training that address the distinct challenges of both traditional and digital pedagogy.

For traditional settings, this might include investments in classroom management training, adequate funding for materials and technology, support for differentiated instruction, and professional development in culturally responsive teaching. For digital settings, this should encompass comprehensive technology training, infrastructure investment to address the digital divide, strategies for fostering virtual engagement, and attention to teacher wellness and work-life balance. Digital technologies should therefore not be understood simply as substitutes for conventional teaching practices. Rather, technological innovation can reconfigure teachers' roles, pedagogical responsibilities, and the nature of educational work itself [12]. In this sense, digital technology does not simply eliminate traditional pedagogical barriers; it may transform existing barriers and generate new ones.

Furthermore, the findings underscore the socio-technical nature of education. The barriers are not purely technical or purely social; they are an entanglement of both. The digital divide is as much a social issue of equity and justice as it is a

technical one of access. Teacher burnout in remote settings is a product of both the technological demands of learning new platforms and the emotional labor of trying to maintain meaningful connection at a distance. Therefore, solutions must also be socio-technical, combining technological innovation with a deep understanding of human behavior, social dynamics, and educational psychology. This might include designing user-friendly platforms that reduce cognitive load, creating policies that protect teacher time and boundaries, and fostering communities of practice where teachers can share strategies and support one another.

5.3. *Contextual Factors and Study Limitations*

The intersectionality of teacher experiences also warrants attention. While this study did not explicitly analyze demographic differences, qualitative data suggested that rural teachers faced particularly acute challenges with the digital divide, while urban teachers often struggled more with classroom management and student diversity. Early-career teachers appeared more vulnerable to burnout in digital contexts, while experienced teachers sometimes struggled more with technological literacy. Future research should explicitly examine how teacher demographics, school context, and pedagogical barriers intersect to shape the teaching experience.

Several limitations should be acknowledged. First, the purposive sample of 50 K–12 teachers limits statistical generalizability. Second, recruitment through professional networks, educational associations, and online forums may have introduced self-selection bias. Third, the study relied primarily on self-reported perceptions rather than classroom observations or objective measures of instructional effectiveness. Fourth, all participants were drawn from the United States, which limits the transferability of the findings to educational systems with different technological infrastructure and institutional structures. Finally, the cross-sectional design captures perceived barriers at one point in time and cannot establish causal relationships.

6. CONCLUSION

This study provides a comparative analysis of the barriers perceived by K–12 teachers in traditional and digital teaching contexts. Our mixed-methods approach revealed two distinct but related sets of challenges. In traditional classrooms, barriers related to classroom management, resource scarcity, student diversity, and parental communication are paramount. In the digital realm, these are supplanted by challenges of the digital divide, technological literacy, student engagement, and work-life balance. Importantly, the barriers in digital contexts were more universally experienced and, in many cases, more acute than those in traditional settings.

This research contributes to a more nuanced understanding of the complex realities of contemporary teaching. The primary implication is the need for context-specific, dual-pronged support systems for teachers that address the unique challenges of both physical and virtual learning environments. Schools and districts must invest in both traditional classroom resources and digital infrastructure, provide differentiated professional development, and create policies that protect teacher wellbeing. At the policy level, addressing the digital divide requires not only technological solutions but also systemic attention to equity and access.

Future research should build on these findings to explore the long-term impacts of navigating these dual barriers on teacher retention, job satisfaction, and student outcomes. Longitudinal studies tracking teachers over time could illuminate how exposure to these barriers affects career trajectories and professional identity. Additionally, intervention studies testing the effectiveness of specific support strategies in addressing these barriers would provide valuable evidence for practice. Finally, research examining the experiences of teachers in hybrid models, which combine elements of both traditional and digital teaching, could offer insights into how to design more resilient and adaptive educational systems.

The findings of this study underscore the importance of recognizing teaching as a complex, context-dependent practice that requires ongoing support, investment, and attention to the lived experiences of educators. As education continues to evolve in response to technological change and societal challenges, understanding the barriers teachers face across different contexts is essential for creating more equitable, effective, and sustainable educational futures.

REFERENCES

- [1] Stringer, L. R., Lee, K. M., Sturm, S., & Giacaman, N. (2022). A systematic review of primary school teachers' experiences with digital technologies curricula. *Education and Information Technologies*, 27(9), 12585-126
- [2] Al Mazrooei, A. K., Hatem Almaki, S., Gunda, M., Alnoor, A., & Manji Sulaiman, S. (2022). A systematic review of K-12 education responses to emergency remote teaching during the COVID-19 pandemic. *International Review of Education*, 68(6), 811-841.07.
- [3] Marzano, R. J., & Marzano, J. S. (2003). *Classroom management that works: Research-based strategies for every teacher*. Ascd.
- [4] Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice*. teachers college press.
- [5] Darling-Hammond, L. (2004). The color line in American education: Race, resources, and student achievement. *Du Bois Review: Social Science Research on Race*, 1(2), 213-246. <https://doi.org/10.1017/S1742058X0404202X>
- [6] Van Dijk, J. (2020). *The Digital Divide*. Cambridge: Polity Press. Communication, 2020.
- [7] Tondeur, J., Van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: A systematic review of qualitative evidence. *Educational technology research and development*, 65(3), 555-575. <https://doi.org/10.1007/s11423-016-9481-2>
- [8] Means, B., Bakia, M., & Murphy, R. (2014). *Learning online: What research tells us about whether, when and how*. Routledge.
- [9] Reimers, F., & Schleicher, A. (2020). *Schooling disrupted, schooling rethought. How the Covid-19 pandemic is changing education*. <https://doi.org/10.1787/68b11faf-en>
- [10] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- [11] Kraft, M. A., Blazar, D., & Hogan, D. (2021). The effect of teacher coaching on instruction and achievement. *Educational Evaluation and Policy Analysis*, 43(4), 540-566. <https://doi.org/10.3102/0034654318759268>
- [12] Selwyn, N. (2019). *Should robots replace teachers?: AI and the future of education*. John Wiley & Sons.

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AVAILABILITY OF DATA

Not applicable.

ETHICAL STATEMENT

All participants provided written informed consent prior to participation. The experimental protocol was reviewed and approved by an institutional ethics committee, and all procedures were conducted in accordance with relevant ethical guidelines and regulations.

AUTHOR CONTRIBUTIONS

Jiao Jiang and Yousheng Yao jointly contributed to the conceptualization and design of the study. Both authors contributed to the development of the research methodology, data collection, data analysis, and interpretation of the findings. Jiao Jiang prepared the initial draft of the manuscript, while both authors contributed to the critical revision and editing of the manuscript. Both authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

COMPETING INTERESTS

The authors declare no competing interests.

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