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From blackboard to smartphone: exploring the digital revolution in teaching and learning practices

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Abstract

Purpose – This study is intended to explore the shift from conventional classroom delivery to smartphone-mediated digital learning in higher education of Bangladesh.

Design/methodology/approach – Qualitative research method was adopted for this study. For a deeper understanding of the matter, respondents were divided into three clusters. Cluster A1-students from urban areas studying in public or private universities. Cluster A2-students from rural areas studying in public universities or colleges under the national university. And Cluster B- teachers with experience in conducting online or hybrid classes. Data was collected via in-depth interviews in the form of conversations. Thematic analysis was done to present the research findings.

Findings – The research findings showed that the smartphone screen is now the main learning device, and learners favor low data format, asynchronous content, but it works in areas with patchy internet coverage, supported by brief playbacks of live sessions and recaps. Rural learners are often navigating multiple layers of challenge: their devices tend to be older than those carried by their urban counterparts, they generally only have mobile data connections and study spaces can be a limited luxury in the home. Institutional support, slim-bandwidth content design, accessibility features and center-aligned resource support are determinants of equitable participation.

Originality/value – This research argues that a mobile-first and inclusive teaching approach, supported by effective digital transformation, can help reduce existing educational inequalities.

Keywords Smartphone, Mobile learning, Digital transformation, Educational ecosystem

Paper type Research article

1. Introduction

Over the past five years, the educational ecosystem of a developing nation like Bangladesh has undergone a remarkable transformation in response to rapid technological change and expanding connectivity (Shahriar *et al.*, 2021). What was once a familiar scene of chalk on blackboards and rows of students in traditional classrooms has gradually given way to a learning environment shaped by smartphones, digital platforms and virtual spaces (Wang, Qiu, Zhuang, Cao, & Gao, 2024). Since mobile networks and the Internet arrived in the remotest parts of the country, and as mobile phones became increasingly cheaper, education began to break free from the physical limits of school buildings. Consequently, lessons, homework and talk pass through the app's instant messages, group loudspeaker and website portals (Eva, Akter, Zabeen, & Shahriar, 2024). There is no question that the internet puts knowledge and, therefore, all people into a more accessible, flexible manner than ever before (Culduz, 2024). Suddenly, people are learning remotely in every kind of place imaginable, in ways that were unprecedented for any other medium. This shift does not represent the end of Bangladesh's journey toward a digitally connected education system; rather, it highlights a new phase of that journey, where digital learning is becoming more common, more necessary and more deeply linked with everyday academic life (Shahriar, Akter, Sultana, Arafat, & Khan, 2023).

This change is driven by several converging factors, including a government push for "Digital Bangladesh" initiatives, the increasing affordability of smartphones and the expansion of 4G and mobile networks into remote rural areas (Hossain, 2022). This change affects not only the content of what is taught and the geographical locations of classes, but also how students access teaching materials and information, as well as pedagogical strategies, assessment methods and the role of educators in student learning (Momen, Sultana, Hoque,

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Shahriar, & Ashif, 2023). In higher education institutions and schools alike, smartphones serve as portable classrooms, facilitating collaborative projects, instant access to academic resources and personalized learning experiences. Inevitably, though, there are also substantial challenges associated with this change, issues surrounding digital literacy, uneven access to devices and stable internet, or the teaching training necessary for teachers involving technology integration (Shahriar & Akter, 2026). The extent to which these pressures will affect traditional higher education and how they can counteract them through promoting increased profit should not be underplayed. There are concerns about defining the boundary between traditional, face-to-face teaching and technology-led lessons, particularly in a society that values personal relationships with teachers (Shahriar, 2025).

This study will investigate the use of new digital technologies and their effects on teaching and learning. It will consider how different patterns have emerged as a result of integrating information technologies into schools, what the obstacles hindering fair and equal opportunities are and what progressive educators can do to counter an increasingly vast digital canvas.

2. Literature review

2.1 Policy background in Bangladesh

Digitalization has made a major transformation in education within the last few years (Schmidt & Tang, 2020). Bangladesh had adopted various measures to accommodate changes considering the pace of global trends and technological advancement in the education system; Bangladesh's "Digital Bangladesh" agenda explicitly positioned information and communications technology (ICT) as a lever to expand access and create an ecosystem and improve quality, culminating in a national policy for ICT in Education (Shahriar, Alam, & Arafat, 2019). The policy accentuated the internet connectivity, availability of digital content, scope for capacity building and change management across school and higher education institutions (Shohel, Ashrafuzzaman, Mahmud, Azim, & Khan, 2023), laying the groundwork for platform, device and teacher-training investments that followed. This agenda set out a clear vision from the government for the nation's next big leap. It aimed to transform the education system and national capacity-building ecosystem to equip their people with the right skill sets and infrastructure needed to compete in the global digital economy (Waughen, 2015; Sabur, 2019).

2.2 Transformation of educational ecosystems in Bangladesh

Previous studies had shown that innovation in learning, including distance learning, online education and m-learning, has moved from "supplementary" to "central" in mainstream education, especially during the global COVID-19 pandemic (Sultana, Eva, Akter, & Shahriar, 2025). It was a reality that during the pandemic, online learning was the only way to continue the learning practice; perceptibly, learners from all socio-economic backgrounds could not afford it, especially considering a developing country's perspective like Bangladesh (Eva *et al.*, 2024).

However, the country took different initiatives; except for formal individual institutional boundaries, it deployed a multi-channel blend like TV for broadcast lessons, university network platforms and national e-learning portals (Arefin, Chowdhury, Roy, Rahaman, & Cross, 2023). Evaluations and rapid assessments found broadcast reach but mixed engagement and remote learning time, signaling constraints of one-way delivery with limited interactivity & support.

At the same time, the teachers' digital skills play a key role in how much impact technology can have in classrooms. In Bangladesh, research has shown that there are still gaps in things like school infrastructure, training in using ICT for teaching and making sure the curriculum works well with digital tools (Shahriar *et al.*, 2021). Recently, researchers highlighted that many teachers still lack access to enough devices, reliable internet and the know-how to confidently use technology in their teaching subject (Nurshuzishafiqah, Din, & Othman, 2022). However, it was essential that the government provide sustained and significant

attention to upskilling teachers, not just in terms of technology use but also the underpinning pedagogical practices required to successfully embed it into everyday teaching (Shohel & Kirkwood, 2012). For whatever reason, this area was overlooked and not given the attention it quite needed (Haque, 2025; Jahan, Shaha, Hossain, & Islam, 2025). While there were short-term training sessions, especially during COVID-19, they often lacked the depth and continuity required for real, lasting change (Sultana, Afroje, & Shohel, 2023). Importantly, strong institutional efforts to back up these initiatives were not very visible. Without coordinated policies, consistent follow-up and proper support systems in schools, many teachers were left to figure things out on their own, which made it harder for them to build the confidence and competence to fully embrace technology in the classroom (Ferdousi, Ahmed, & Momen, 2022).

2.3 Future of learning and reality

Smartphones have become the most common and easy way for students to connect with distance learning (Hasan, Karimuzzaman, Abdulla, & Hossain, 2024). For many students, especially in rural and semi-urban areas where access to computers is limited, the phone is the only practical tool for studying, joining online classes and staying in touch with teachers and classmates (Bravo-Sánchez, Morán-García, Abián, & Abián-Vicén, 2021). Students have generally embraced this global transformation of education, but their experiences vary significantly depending on their location and resources (Derveni & Dagdilelis, 2020). The cost of mobile data, the strength of internet connections, and whether they live in a city or village all affect how much they can actually benefit from mobile-based distance learning.

Phones have made it easier to access lessons, share notes and use apps that support flexible learning, but the real impact depends on how well materials are designed for small screens, whether teachers feel confident guiding students online and if assessments remain fair and accessible (Fu, Chen, & Zheng, 2021).

Many teachers, however, still struggle with limited training opportunities, heavy workloads and little institutional support, which means long-term skill development has not received the attention it deserves. Even so, pilot projects in the country have shown that when teachers are given proper guidance, useful resources and practical ways to apply them, mobile learning can strengthen classroom practices and improve outcomes (Dahal & Bhat, 2023). Looking to the future, it is clear that education in Bangladesh will continue to move toward a mobile-first model, but its success will depend on making learning affordable, inclusive and supported by strong teacher development and sound policies.

2.4 Mobile learning and its importance

Mobile learning (m-learning) captures the shift from fixed, teacher-centered classrooms to ubiquitous, learner-centered ecosystems built around devices students already carry (Naveed, Choudhary, Ahmad, Alqahtani, & Qahmash, 2023). Across literature, its importance is tied to three reinforcing gains: access, personalization and authenticity. First, in recent times, mobile devices have widened access by lowering hardware costs, supporting offline use and providing built-in accessibility features that aid multilingual, neurodiverse and disabled learners in developing countries (Husnita, Rahayuni, Fusfitasari, Siswanto, & Rintaningrum, 2023). Second, they enable personalized pathways through microlearning, push-notification nudges and spaced-practice quizzes that adapt to pace and need, strengthening retention and self-regulation (Wang, Bakhet, Roberts, Gnani, & El-Osta, 2020). Third, mobiles situate learning in real contexts, geo-tagged fieldwork, photo, video annotation, augmented reality and just-in-time search, so concepts travel with the learner beyond the classroom (Chen, Chen, Huang, & Hsu, 2013).

As digital skills are now basic requirements, not extras. Teachers are also shifting roles from only delivering content to guiding and supporting students as they learn online and connect with others (Haleem, Javaid, Qadri, & Suman, 2022). For teachers, learning streamlines formative assessment, supports differentiation with multimodal tasks and

complements blended and flipped designs; for institutions, interaction data informs timely feedback and learner support (Narreddy, Joordens, & Prompiengchai, 2025). Crucially, effective learning is not "shrinking lectures to small screens but redesigning for brief, interactive, inclusive experiences while addressing equity (bandwidth and devices), distraction management, data privacy, and digital well-being (Hussain, Qureshi, & Malik, 2024). When these design and policy conditions are met, smartphones become a bridge between formal curricula and everyday life, turning anytime, anywhere" connectivity into durable understanding and participation (Shahriar & Akter, 2025).

3. Purpose

This research explores how the growing use of smartphones is reshaping the learning experiences of undergraduate students and what this means for creating fair, high-quality mobile learning from the perspective of a developing nation.

4. Methodology

Anchored to the objective of this study, the authors employed an exploratory-qualitative research design to surface nuanced student and teacher experiences. Here, as the concept is exploratory and capturing the experiences of the participants is an important qualitative research approach. This approach lets them hear directly from students and teachers about phone use, weak networks, power cuts and heavy files. Interviews allowed follow-up questions, real examples and clear contrasts between students and teachers.

Initially, the researchers designed guiding questions to explore students' experiences with the digital transformation of teaching and learning practices in Bangladesh. Based on this, two clusters of participants were identified. In the first cluster, around 81 students were initially approached, while in the second cluster, approximately 41 teachers were considered for participation. Following initial conversations and screening, the final pool of respondents was selected for more profound interviews and focus group discussions. Using the purposive sampling technique through private-university student groups in the social networking site (SNS) Facebook, 48 undergraduate participants were recruited and organized into two contrastive clusters to reflect Bangladesh's digital divide. Cluster A1 ($n = 24$): students residing in Dhaka and suburban areas, all studying in the private or public universities located in urban areas; Cluster A2 ($n = 24$): students based in rural or semi-rural districts, studying in public universities or local colleges under the national university; and Cluster B ($n = 18$): teachers from both private and public universities in Bangladesh. These clusters are meaningful because network quality, power supply, devices and support differ by place. The same phone gives different learning chances in each setting.

The criteria for teachers included currently teaching at a Bangladeshi university, having online or hybrid teaching experience and consenting to be interviewed. Students were recruited through private-university Facebook groups; teachers through professional networks. Before joining the study, each participant received an information sheet that explained what the research was about, what they would be asked to do, how long it would take and how their information would be used and protected. They were told that taking part was voluntary and that they could stop at any time without any problem. After reading it and asking any questions, they agreed to participate by giving informed consent. Researchers conducted in-depth interviews. Here, most of the interview sessions were conducted online via phone and mobile apps like Messenger and WhatsApp between February and July 2025. Each interview session took 35–60 minutes; among the 55 participants, 20 participants were re-interviewed for better clarification of the theme. 39 interview sessions were audio-recorded with the consent of the participants, and others were captured via detailed field notes by the authors.

Data was analyzed through reflexive thematic analysis, combining deductive codes with inductive codes emerging from practice.

5. Findings

5.1 Devices and access

The research findings showed that around 100% of the respondents from all clusters agreed that smartphones are the foundation of access to distance learning. But the potential of that phone, its age, storage size, screen size and physical condition determined what students would realistically be able to do with it.

Findings revealed that in rural and semi-rural settings, older handsets and cracked screens meant sluggish reading, frequent input errors and daily challenges to scrape up enough space for downloads and updates. Nonetheless, 54% respondents from the cluster-A1, 83% respondents from the cluster A2 associated the smartphone with their "default classroom" where they do not just attend live sessions but also read, submit assignments and carry out collaborative tasks.

As one of the Cluster A1 students said-

> Most of my course is on my phone; slides, quizzes and the class group are all here. After attending my regular offline classes, even when I am by a computer at home, I still check the directions or email on the phone first. – Respondent 09_ClusterA1_Dhaka

A ClusterA2 student noted-

> During the online classes, my phone becomes my campus. The day the battery dies or Wi-Fi is gone, is the end of class for me, even if the teacher continues speaking. . .. . – Respondent 31_ClusterA2_ Tangail

But the revelation of access is not a static state; it is a series of perpetual accommodations. They reported using multiple SIM cards to make data plans last, borrowing hotspots from family members and scheduling downloads to the wee hours of the morning in order to benefit from cheaper rates. For a lot of them, the true test of "accesses" was not whether there is a platform available, but rather if these files were small enough for downloading and usable offline without perpetually streaming video.

Table 1 showed that while phones are the most commonly accessed device for learning for all the clusters, this role, as it was in education, does seem to differ across contexts. For students in urban and suburban areas in cluster A1, phones are primarily available and convenient, even where ubiquitous laptops also exist, due to apps, logins and group communication.

By contrast, rural students (Cluster A2) use phones out of desperation, with "ecological constraints" such as obsolete devices, weak mobile-only connections and power cuts making a phone their only viable option.

Teachers are responding to this reality by creating phone-friendly material, but that in turn begs the question of whether such education standards are being dumbed down or made more inclusive. One of the respondents from cluster B mentioned

> Yes, almost everyone has a smartphone. But many students use old phones. Some phones are slow, some have little storage, and some screens are broken. Because of this, they cannot download files or join online classes properly. That is why I try to make small-size PDFs and short videos. Still, sometimes I feel the learning quality becomes limited.

– Respondent 51_Cluster B_Dhaka

Another responded and added that

> Smartphones help students to attend classes, but the experience is not the same for everyone. Students from Dhaka usually have better internet and better phones. But rural students often face network problems. Even if they have a phone, they cannot join smoothly. So, smartphones are helping access, but they also show the inequality between students.

– Respondent 59_Cluster B_Dhaka

Table 1. Smart Phone as learning tool in Bangladesh Higher Education

Perspective	Laptop access & use	Stacked constraints (devices, power, data, spaces)	Connectivity & participation
Cluster A1: Students in Dhaka & suburban areas	Around 96% have some access to laptops, desktops or Tab, but many still finalize tasks via phones Phones are central because logins, notifications, group chats are phone-based Even with laptops, students prefer submitting via phone for convenience and integration	Fewer "stacked" barriers compared to rural peers, but still report outdated laptops that lag or crash Phones perceived as more reliable, faster to open apps/ learning platforms	Higher broadband access than other groups (urban households) Phones ensure mobility and flexibility; students can switch between Wi-Fi and mobile data Optimized phone content reduces stress
Cluster A2: Students in rural & semi-rural areas	Much lower laptop access; often rely on borrowed or shared devices (siblings' laptop for assignments) Phones not just supplementary but primary tools for drafting, submitting and even extended typing (when laptops are unavailable or unusable)	Face "stacked constraints": Old/overheating phones. Around 79% respondents confirmed the reliance on mobile-data-only connections. Frequent power outages Limited quiet spaces Phones become critical for short, offline-accessible, data-light learning materials	Lowest broadband access (most depend on mobile data) Phone-optimized content (small files, downloadable lectures, audio-only participation) is the difference between inclusion and exclusion Phones allow continuity even during outages (charging via small power banks)
Cluster B: Teachers in public & private universities	Many teachers own laptops or desktops, but recognize students' unequal access Increasingly design learning materials to be phone compatible (smaller file sizes, WhatsApp/FB group sharing)	Aware of rural students' device and power limitations Acknowledge phones as the "lowest common denominator" device design around them, rather than for laptops or desktops	Report home Wi-Fi access itself, but adjust practices (e.g. flexible deadlines, asynchronous submissions) to accommodate students with only mobile data Accept phone-based submissions (photos of handwritten work, voice notes, short essays)

Source(s): Authors, Interview analysis

Ironically, while smartphones appear to function as an equalizer, they also conceal important differences in learning conditions. Students from urban and suburban areas often reported smoother access due to more stable internet connectivity and better broadband coverage, whereas students from rural and semi-rural areas frequently faced limited network availability, slower speeds and disruptions even when they owned smartphones. Therefore, smartphones simultaneously support continuity and inclusion in digital learning while also reflecting deeper structural inequalities within higher education.

5.2 Preferred learning mode and pacing

Research findings showed that students across both clusters, A1 and A2, strongly favored learning designs that are 1) mobile-first, 2) low-data and 3) broken into short, clearly sequenced learning content units that they can complete on their own schedule.

One of the respondents from cluster B mentioned that

> From my experience, students always tell me they cannot manage long live classes. Many of them shared that data cost is high and the network is unstable. Some students even said they attend classes late at night because the internet works better. That is why I started giving recorded videos, slides, and short voice notes, so they can learn anytime.
>
> – Respondent 64_Cluster B_Dhaka

The dominant preference was for asynchronous resources like downloadable slides, concise recorded explanations and brief voice notes paired with simple prompts or mini-quizzes that help them self-check progress without staying online for long stretches. Long live sessions were consistently described as fatiguing and impractical given data costs, network instability, shared devices and power interruptions; when live meetings are necessary, students asked that they be short, tightly focused and accompanied by written summaries so that anyone disconnected can catch up.

Respondent from cluster A2 said

> Live class is hard for me. Data finishes fast and network problem always happens. Sometimes electricity also goes. That's why I like recorded video and slides. I can watch later at night when internet is little better. Short class video is best, long class makes me tired. – Respondent 25_ ClusterA2_Barishal

Another respondent from cluster B added

> I asked my students directly what type of online learning they prefer. Most of them said they want short and simple lessons, not long Zoom sessions. They told me live classes are tiring and sometimes electricity goes off. So now, if I take a live class, I keep it short and I also provide written summaries, because students said they miss parts when the connection drops. – Respondent 60_Cluster B_Dhaka

This pacing preference is intertwined with students' everyday constraints: many study late at night or early in the morning to stretch data packages and to seek a quieter environment, which makes flexible deadlines and predictable weekly rhythms especially valuable.

Table 2 shows how three clusters accommodate their learning and teaching to the actualities of studying by phone. There is a consistent preference for low-bandwidth, asynchronous learning across all clusters, including short recordings, narrated slides and voice notes. This mode enables students to replay challenging sections of their courses without consuming extra data and allows teachers to distribute flexible, lightweight materials that can even be used on low-connectivity networks.

As for live sessions, all groups agreed the shorter the better: 30 minutes or less, with a clear agenda and written follow-up notes. The purpose is that for urban students, this provides focus and less wasted time; for rural students, it prevents dropout due to a bad connection and in terms of the teachers, it maintains engagement without overwhelming the network.

A second strong trend is studying off-peak, whether in the afternoon or early morning or between 7 am and 11 am, as networks are steadier and data costs are lower at that time. This is even more relevant in rural homes where the availability of connectivity and noise are challenges; teachers, too, admit to preparing and reading material during those quiet hours.

The best way of learning is to do so in short, spaced-out sessions with rapid-fire check-ins, small quizzes, or comprehension questions that encourage active processing. Students and teachers agreed that such instruction increases retention over watching long passive videos.

And ultimately, a predictable weekly rhythm helps students cut anxiety and budget time by allowing them to anticipate when new materials, deadlines and feedback will be released. Weekly checklists keep urban and rural students organized. Both urban and rural students depend on weekly checklists to stay on track, while teachers have discovered that there's power in a pattern that students can use to tackle downloads and homework around connectivity problems.

Teachers reported that the growing use of short, mobile-friendly learning materials was not intended to reduce academic quality but rather to respond to students' practical limitations.

Table 2. Preferred learning mode and pacing across clusters

Dimension	Cluster A1	Cluster A2	Cluster B
Preference for Low-Bandwidth, Asynchronous Materials	62% prefer slides, short audio and small recordings; replay helps manage data	Similar preference, constrained by weaker connectivity; download at night to save cost	87% strongly prefer asynchronous, low-data formats like slides with narration and voice notes
Acceptable Length for Live Sessions	66% favor ≤30 minutes, with agenda and recap; avoid long, draining sessions	Prefer shorter sessions due to fragile connections; interruptions make long classes unworkable	89% prefer ≤30 minutes, short goals and recap notes; longer sessions risk dropout
Study Time Scheduling	58% schedule study late at night due to household noise and data use	More pronounced: off-peak studying is the only workable option	80% report studying at night or early morning; download when the signal is steady
Learning in Short Segments with Quick Check-ins	68% benefit from micro-lessons, tiny quizzes; aids retention	Same pattern; quizzes help ensure comprehension despite distractions	83% favor short segments plus 5-question checks for reinforcement
Need for Predictable Weekly Rhythm	62% prefer a weekly release rhythm with deadlines and feedback; reduces anxiety	Consistency is critical; it helps them plan despite intermittent connectivity	54% say weekly rhythm aids planning, downloads and pacing work despite weak networks

Source(s): Authors, Interview analysis

Many students informed teachers that high data costs, weak internet signals, electricity interruptions and limited phone storage made long online sessions difficult to manage. As a result, teachers increasingly relied on recorded explanations, brief voice notes and downloadable slides to help students continue learning without staying connected for long periods. At the same time, teachers acknowledged that complex topics are sometimes difficult to cover in short segments, as extended discussion and deeper engagement are harder to maintain in low-data learning formats.

5.3 Content weight and accessibility

This research presents a detailed analysis of how content weight and accessibility influence digital learning experiences across three clusters; drawing on verbatim responses and comparative interpretation, the findings demonstrate that while smartphones have enabled continuity of participation, the size, format and storage demand of learning materials remain critical barriers to equitable access.

One of the respondents from cluster A1 said

> I have smartphone and Wi-Fi, so I can join classes. But sometimes teachers give big files like heavy PDF or long video. My phone storage becomes full very fast. Then I cannot download properly. Some videos also take too much time to load. If the file is small and clear, it becomes much easier for me. – Respondent 3_ClusterA2_Rajsahi

For urban and suburban students, digital use was less a result of overt device scarcity than of how resources fit into mobile data budgets or the affordances of particular devices. Large files exceeding 100 MB or the need for uninterrupted streaming were a frequent barrier to access for almost half, according to 42% respondents. Many of these students had reasonably reliable home broadband or shared family Wi-Fi but were still constrained at crucial times like deadlines or study binges.

Students in rural and semi-rural districts faced an even more pronounced problem with heavy files. Unlike their city counterparts, these students mostly had no broadband at all and were dependent on prepaid mobile data bundles. Faced with a 300 MB video or a slideshow

full of images, students had to choose between spending a large portion of their weekly data allowance on one class or missing out entirely. Couple that with a bad signal, making continuous streaming impossible. There were students who detailed how power outages or a lack of network had led to downloads getting constantly interrupted halfway. Students described that uncertainty around file downloading and submission created a strong sense of pressure and hesitation, particularly among those with limited data and unstable network access. Many reported that they often expected the file to fail to download, the internet to disconnect, or the upload to be incomplete, which discouraged them from attempting to access learning materials repeatedly. This constant need to calculate data cost, storage space and connection reliability made participation more difficult, especially for rural and semi-rural students. As a result, large file sizes emerged as a major barrier, reducing students' ability to engage with both synchronous sessions and asynchronous learning resources.

From cluster B, teachers were quite concerned about stimulating factors determining student participation: 76% recognized that the weight of their personal lecture recordings or slide decks was sometimes too heavy to download for students. Some teachers described tension between pedagogical comprehensiveness and accessibility.

Around 83% of respondents from cluster B expressed that they depended on broadband and could access high-bandwidth resources while acknowledging that their students' realities necessitated lighter formats. Some had started creating narrated slides, quick audio summaries and lower-quality files at the request of their students. Teachers also mentioned having to instruct students about when and how to download to avoid cost, revealing a pedagogy not only focused on content delivery but also on digital survival techniques.

5.4 Format and design choices determine readability

Urban and suburban students reported that design elements such as single-column layouts, larger fonts and high-contrast colors significantly improved their ability to engage with digital resources on smartphones, with 100% of respondents from cluster A1 affirming these benefits. Even when broadband access was more stable, the physical constraints of small screens meant that poor formatting often undermined learning. Likewise, 100% of the respondents from the A1 cluster highlighted that two-column slide designs, common in traditional classroom contexts, were particularly problematic, as they disrupted flow and comprehension.

Respondents from cluster A2, rural and semi-rural students, expressed challenges in learning as a result of the poor design, which includes small-screen readability, unstable networks and weaker devices. 100% mentioned that poorly formatted materials required too much effort to zoom in on the course content if it was difficult to read. The situation was not just confusing but also a time- and battery-saving inconvenience. When the materials were in the format of image scans of handouts, more than 90% of the respondents considered them almost unusable on restricted-space devices. This group of students was not easily able to switch to a laptop as an alternative, with design flaws contributing directly to marginalization. In the A2 Cluster, 71% insisted that formatting issues were not minor nuisances but rather severe obstacles to participation.

Approximately 61% of cluster B respondents (teachers) reported that design and format had a strong influence on learning engagements. One of the teachers shared-

> Image scans of handouts are impossible to read on my phone; searchable text documents are much better. – Respondent 57_Cluster B_Dhaka

Some considered their habits and the allure of scanning handwritten notes or sharing existing slide decks, which creates a barrier for students.

5.5 Institutional reliability and support

Students' experiences of digital learning were shaped not only by their devices and data budgets but also by the reliability of institutional systems and the supports wrapped around

them. When the learning management system was stable, when libraries and electronic resources worked off-campus, when there were predictable windows to use high-quality wireless internet on campus, and when the help desk or teachers responded quickly, students reported lower anxiety and better continuity. A bare majority of urban and suburban students reported being satisfied with mobile uploads, logins and grade viewing (Cluster A1 58%), while satisfaction was much lower among rural and semi-rural students (Cluster B 17%). Deadline-hour slowdowns were common.

One of the respondents from cluster A1 added

> Sometimes LMS works fine, but during assignment deadline time it becomes very slow. Many times, I cannot upload my file and I get tension. Even login takes time. If the system was stable, it would be much easier for us. – Respondent 8_ClusterA1_Dhaka

Around 86% of respondents from cluster A1, 96% of the respondents from cluster A2 and 94% of respondents from cluster B agreed that unannounced outages, slow or inconsistent technical support and the absence of small but crucial aids, for example, data subsidies, power bank or headset loans and accessible formats, produced missed deadlines and a sense that participation depended more on personal luck than on institutional design.

Respondent from cluster B shared her experience on it -

> From my experience, students perform better when they get quick support. Many students asked me about login problems, access to e-library, or submission issues. If the university system is not reliable, students lose motivation and they panic, especially during exams or assignment weeks. – Respondent 63_Cluster B_Dhaka

100% of the respondents from cluster A2 also agreed that rural and semi-rural students felt these gaps most acutely because they already faced older devices, mobile-data-only connections and frequent power cuts; for them, a single breakdown in institutional reliability often meant the end of that week's learning plan.

Table 3 showed key aspects of institutional reliability and support for mobile-based online learning. 100% of the respondents from the A1 and A2 clusters said they expect the LMS to run smoothly on phones, yet failures like upload hangs or login issues force them to resubmit or email instructors, suggesting that it requires stronger servers and mobile-first themes. Interview analysis also confirmed that clear outage communication is often missing, leaving students to rely on peers, so advance calendars and status dashboards are proposed. Orientation is still desktop-focused, pushing students to learn via peers, illustrating the importance of structured phone-first onboarding. Here, students mentioned that they have no access to device loans and repairs in any institution; it means students delay fixes or share devices, pointing to the value of micro-grants and vendor support. The help desk often ignores mobile-specific needs, so students rely on peers, while staffing peaks and chat support could improve response. Inconsistent course templates force students to make their own checklists, showing the importance of standardized layouts and UX reviews. Library access is often unreliable on phones, driving students to open sites, making proxy upgrades and mobile discovery tools critical. Finally, around 100% of respondents said they get some access to the learning materials or video recordings, but they miss the office comfort of clearing concepts again and again in class or teachers' office hours during the full online classes; thus, students depend on peers for partial notes, reinforcing the need for departmental recap norms and TA support.

6. Discussion

The findings of this research revealed both the significance of smartphones to higher education with the emergence of remote learning and hybrid models in Bangladesh and the deep inequalities that shape their effectiveness as learning tools. While respondents agreed that phones form the starting point for digital participation, the quality of that participation varied sharply by context. Students from the urban areas often treated the phone as a convenient and

Table 3. Institutional reliability and support

Institutional area	What "good" looks like for students	Typical failure modes in 2025	Student workaround when it fails	System-level improvements (next term)
LMS stability	Uploads, logins, grades work on phones	Upload hangs; failed mobile views	Resubmit; email instructor	Scale servers; mobile-first themes
Outage communication	Clear 24h + notices; no clashes	Unannounced downtime	Wait; rely on peers	Annual calendar; learning management system (LMS) status API
Orientation (phone)	Short phone walkthroughs	Desktop-only demo	Peer screenshots; trial & error	Phone-first onboarding; Start Here modules
Device loans/ repairs	Quick headset/ power bank access	No stock; laptop-only	Delay repairs; share devices	Micro-grants; vendor discounts
Help desk	Phone-specific replies <24h	Auto-acknowledge only	Ask peers; miss quizzes	Staff peaks; chat support
Course templates	Same navigation; weekly checklist	Inconsistent design	Personal checklists; reps	Template policy; user experience (UX) review
Library access	Proxy works on phone; offline PDFs	Timeouts; broken links	Open sites; skip readings	Upgrade proxy; mobile discovery
Recaps	Bulleted summaries with next steps	No summaries	Peers; partial notes	Norms; TA support

Source(s): Authors, Interview analysis

integrated device despite having alternative access to laptops, whereas students living in rural areas and studying in universities located in rural areas and students from rural colleges under the national university (Cluster A2) relied on phones out of necessity, facing stacked barriers of outdated hardware, unstable networks and frequent power cuts. At the same time, teachers acknowledged these disparities and increasingly designed phone-friendly content, but the question remains whether such adaptations represent a pedagogical leveling of the playing field or a lowering of academic standards to meet infrastructural deficits.

Patterns of preferred learning mode and pacing are an additional scope, as is how mobile access dictates pedagogy. Both student clusters preferred asynchronous, low-data formats such as narrated slides, short recordings and voice notes, while teachers endorsed these methods as scalable and inclusive. The rejection of long sessions by both the teachers and the students highlights not only bandwidth limitations but also the cognitive load and fatigue associated with unstable connections.

Here, a clear pedagogical point becomes evident: for pacing to be fair (and not just something students want), it also requires flexibility. However, micro units and the asynchronous mode bear the potential risk to decrease possibilities for live dialog and mentorship opportunities, which leads us to question if collective convenience may unwittingly offset a more embodied experience.

The issue of content weight and accessibility illustrates the structural challenges of equitable digital learning. Interestingly, when the practice of mobile-based online education and hybrid mode, both formally and informally, changed the traditional classroom-based learning system, the practice of sharing large files and continuous streaming was commonly identified as a barrier, particularly in Cluster A2, where students sacrifice data budgets or abandon materials altogether. Teachers admitted contributing to the problem, with 76% recognizing their materials were sometimes too "heavy" for student realities. While efforts to produce lighter formats show adaptive responsiveness, this tension highlights a structural contradiction: educational quality, often equated with comprehensiveness, risks being pitted

against accessibility. With the emergence of fundamental tools for digital education, teachers and educational institutions also need to bring innovation to the teaching and learning design. Critical analysis here points to the need for rethinking "quality" itself, not as more content or higher resolution, but as usable, accessible and inclusive design.

The format and design choices of the learning content reveal another layer of inequality in online education. Students from the urban areas flagged readability issues such as two-column slides and non-optimized layouts, while rural students described poor formatting as outright exclusionary. The general agreement that mobile-first design improves comprehension reflects a broader truth: digital equity is not simply about access to devices but also about the usability of resources within their constraints. Teachers' reliance on scanned handouts exemplifies institutional inertia, where established practices persist despite evidence of harm. The critical challenge is to shift design norms away from retrofitted classroom materials toward content intentionally crafted for mobile learning environments. However, here the initiations need to provide critical training on instructional design to the teachers and administrative staff of the departments to design the learning content in simple and interactive ways.

Lastly, institutional trust and support were identified as playing a critical role in students' experiences. Issues around LMS reliability, outage notification, help desk response times and device support simply added to the daily battle that students had to fight. Students in Cluster A1 indicated a moderate satisfaction, while students in Cluster A2 felt extremely excluded, with one system failure reflecting a week less learning. Blair echoed concerns about institutional and policy support being weak, saying the involvement of students often came down to luck rather than design. And that brings me to a critical point of criticism: technology adoption without a concomitant investment in institutional support runs the risk of exacerbating inequality.

Using the Capability Approach (Sen, 1999) helps explain the findings in clear terms: what matters is not just owning the phone, but students' real ability to learn with the gadget. Different "conversion factors" shape the ability of the network stability, power cuts, data costs, file size and format, LMS reliability and the help students receive. In the study, Cluster A1 students from urban areas could turn the same phone into better learning results because these factors worked in their favor; Cluster A2 students from the rural and semi-rural areas faced weak networks, power outages and "heavy" materials, so their capability to learn was much lower. Teachers' design choices and institutional support act as levers that raise or lower capability. This lens also speaks to a VUCA (volatility, uncertainty, complexity and ambiguity) setting: volatile power and data prices, uncertain outages, complex links between tools, people and policies, and ambiguity about what "quality" means. Framed this way, the results argue that quality should mean materials and systems that people can actually use under these conditions: small, readable, offline-ready and backed by reliable support, so that students' real freedoms to learn expand across contexts.

7. Conclusion

The transition from blackboard to smartphone in higher education points to both the transformative potential and longstanding hurdles of a mobile-first learning environment. Smartphones have been democratizing education by offering flexible learning environments that are just in time and place for people, but the promised advantages of ubiquitous access are not equally available because uneven quality of devices, connectivity and support exist between users. Using a simple capability lens, it shows how networks, power, data costs, file size, LMS reliability and support services either enable or block real learning. This helps the theory by linking teaching quality to the conditions that make learning possible. It also points to clear policy actions: mobile-first design rules, lighter files, zero-rated or subsidized access, device support, uptime targets, outage alerts and service metrics that advance fair access.

It combines ideas from education, technology studies, sociology and development, public policy and governance, including digital Bangladesh standards and funding and communication studies. Together, these pieces show that digital higher education is a system: pedagogy, infrastructure and institutions must be designed and managed together.

However, the sample is qualitative and purposive, not statistically representative. The focus is on selected regions and institutions in Bangladesh, so findings may not fit every setting. Data were self-reported and collected under uneven connectivity, which may have shaped who took part and what they shared. The potential of the digital education agenda can be achieved in its totality only when universities and the policy community come together to ensure that the customer-centricity narrative is grounded in equity, inclusion and sustainability.

8. Research implications

The findings imply that future research should treat smartphones as the main learning device and test which mobile-first formats lead to better learning outcomes. Studies should compare mobile-optimized resources with standard materials, examine whether access supports reduce rural–urban and income gaps and identify which on-screen design features most affect comprehension and persistence. Research should also link system reliability indicators to engagement and completion, and evaluate which interventions deliver the best impact per cost for scaling across universities.

9. Practical implications and recommendations

This study implies that Bangladeshi universities can improve phone-based teaching quickly and at low cost by adopting a mobile-first standard: make all materials easy to read on small screens such as single-column slides, big fonts, clear layout, keep files small, around 10 MB or less; using compression and a “file-weight check” before upload, provide captions or transcripts and offline packs so learning works with weak data, deliver short lessons with a weekly live questions and answers (Q&A) sessions, and train teachers/staff to design for mobile and low bandwidth; in practice, universities should also send SMS outage alerts, run a same-day help desk and set LMS uptime targets, while giving rural/low-income students extra support through loaner phones, data vouchers or zero-rated LMS access, download hubs and reliable study spaces with power; for policy, quality standards can require mobile-access rules such as file limits, low-data formats, flexible deadlines during outages, fund device or data programs and publish simple metrics like average file size, uptime, help-desk wait time, access by region and future research should test which mobile-first designs most improve learning outcomes, reduce rural–urban gaps and deliver the best cost-benefit.

10. Future research direction

Future studies should test run simple trials comparing light vs. heavy course files, short vs. long videos and live vs. asynchronous formats, and then measure learning, access and dropout. Long-term tracking can follow students across semesters to see how device loans, data support and teacher training change results over time.

Mixed methods will help in such research, surveys for scale, interviews for depth and learning analytics used carefully and with consent. Comparative studies across public, private and national university colleges can show which policies and LMS features give the best value for money. Equity lenses are key, look at gender, disability, first-generation status and language.

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