From Digital Divide to AI-Ready Classrooms: Lessons from COVID-19 for Designing Equitable AI-Supported Education in Jordan

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Abstract

This study investigates Jordanian students' experiences with emergency online learning during the COVID-19 pandemic, focusing on how resource limitations and access inequalities shape learning processes and outcomes. It further considers how lessons from the digital divide can inform the development of equitable, AI-ready education systems in Jordan. Drawing on Cooper's framework, the Digital Inequality perspective and the Community of Inquiry model, the analysis explores the role of infrastructure, household resources, and instructional interaction.

A non-probability sampling strategy combining purposive and snowball sampling techniques was employed. Teachers and parents from diverse geographical regions were selected to ensure broad representation and were invited to disseminate the survey through their networks. The online survey yielded 2,759 valid responses from students in public (93.6%) and private (6.4%) schools.

The findings reveal substantial gaps between access and effective learning. Only 47.7% of students perceived online learning as effective, while 81.4% reported difficulties in understanding complex concepts. Resource constraints were widespread: 90% relied primarily on mobile phones, 82.2% shared devices, and 81.1% experienced unstable internet connectivity. Public school students were disproportionately affected, with 60.2% lacking essential home learning materials. These conditions limited interaction, contributed to platform-related difficulties (63.6%), and reduced engagement, with 80.8% preferring face-to-face learning. Perceived effectiveness correlated significantly with internet quality and device availability ($p < .001$).

The study highlights that equitable online learning requires reliable connectivity, adequate devices, supportive home environments, and stronger instructional interaction, with implications for equitable AI adoption in education.

Keywords: emergency remote teaching, digital divide, educational equity, COVID-19, mobile learning

1. Introduction and Literature Review

The COVID-19 pandemic has caused major disruptions in education worldwide. When schools were closed to help control the spread of the virus, approximately 90% of students globally were affected (UNESCO, 2020). Therefore, schools had to quickly shift from traditional classrooms to online learning. This change highlighted the importance of technology in education but also revealed gaps in access to devices, internet connectivity, and digital readiness (Al Bataineh et al., 2021). Many schools and universities had very little time to prepare, which made the transition even more challenging in contexts like Jordan, where the sudden shift to emergency remote teaching revealed inequalities and highlighted pre-existing challenges (Audah et al., 2020). Studies examining the pandemic's impact on Jordanian education underscore the difficulties faced by students and teachers. Research on teacher preparedness, such as the study by Alkhwaja and Seitan (2022) on the extent of teachers' knowledge of required skills in distance education in Jordan, reveals the need for enhanced professional development and support for educators navigating the complexities of online instruction. Instead of stopping learning altogether, governments and educational institutions used the tools at their disposal to keep students learning (UNESCO, 2020).

Like many other countries, Jordan's education system experienced disruptions during this period. Following the nationwide lockdown announced in March 2020, all schools and universities transitioned rapidly to online learning. In response, the government launched the "Darsak" online platform alongside two educational television channels to broadcast lessons for grades 1–12 in core subjects such as English, Science, Arabic, and Mathematics (Barron et al., 2021). The Ministry of Education has also introduced online professional development programs to support teachers in acquiring essential digital skills and adapting to new pedagogical approaches in the classroom. While these initiatives reflected a strong national commitment to sustaining learning continuity, they simultaneously exposed persistent challenges related to internet connectivity, device availability, and disparities in teacher preparedness across regions and school types.

Studies from many countries have reported similar challenges in online learning. Students often struggle with poor internet connections, limited access to devices, and a lack of technical support (Agarwal and Kaushik, 2020; Bahasoan et al., 2020; Mukhtar et al., 2020). A large proportion also experienced emotional difficulties such as stress, boredom, and low motivation (Hassan et al.,2021; Irawan et al., 2020). Research from India, Indonesia, and Arab countries has revealed that online learning outcomes depend heavily on students' home environments, socioeconomic backgrounds, and school resources (Adnan & Anwar, 2020; Russ & Hamidi, 2021).

In Jordan, the shift to online learning has highlighted many long-standing issues. Several studies have examined how teachers managed sudden changes. For example, Alkhwaja and Seitan (2022) found that many teachers needed more training to feel confident in teaching online. Other research, such as Al-Salman and Haider (2021), focused on university students and showed challenges related to engagement, access to technology, and mental health (Almomani et al., 2021). Additional studies have examined the overall quality of distance learning in Jordan (Toubasi et al., 2022). Parents also played a major role in school closures. Research from the Philippines and Jordan shows that parents faced significant pressure in supporting their children's online learning, especially when resources were limited (Miguel et al., 2021; Al-Awidi and Al-Mughrabi, 2022; Jan, 2020). Other studies have explored the experiences of parents of children with disabilities, who face even greater challenges (Abuhammad, 2020; Rababah et al., 2022).

Although there has been extensive research on online learning during COVID-19, fewer studies have focused specifically on school students in Jordan (Ahmad, 2021). Much of the existing work has examined university students, teachers, and parents. This study helps fill this gap by focusing on the experiences of 2,759 students from public and private schools across different regions of Jordan. It aims to offer a clearer picture of how students experienced online learning during the pandemic. This study addressed the following questions:

> How effective was the shift from in-person learning to online learning during the pandemic from the students' perspectives?
>
> What structural and instructional challenges did Jordanian students encounter during emergency online learning?
>
> How did students evaluate their overall online learning experience and instructional modality preferences during the pandemic?

This study employed a survey adapted from Owusu-Fordjour et al. (2020) to examine students' experiences with online learning in Jordan. The analysis is guided by Cooper's model of online learning effectiveness, which provides a structured lens for evaluating three critical dimensions: (1) access to devices and reliable internet connectivity, (2) teacher preparedness and the quality of instructional practices, and (3) student readiness, encompassing digital competencies and home learning environments. Using this framework helps clarify the conditions that influence students' engagement and outcomes during online learning. In addition, the study's focus on teacher preparedness and instructional adaptation aligns with the insights later emphasized by Nassereddine and Nassreddine (2024), who highlighted the importance of continuous professional development in supporting teachers as they transitioned to new pedagogical approaches. Together, these perspectives support a comprehensive understanding of the factors shaping students' online learning experiences and their implications for improving future digital education initiatives.

2. Method

2.1 Research Design and Context

This study used a quantitative survey design to explore how Jordanian school students experienced online learning during the COVID-19 pandemic. Jordan, a Middle Eastern country with a population of over 10 million, has a young

demographic, with more than 40% of its population under the age of 18 (Department of Statistics, 2020; World Bank, 2024). The school system includes two main stages: basic education (grades 1–10) and secondary education (grades 11–12), with basic education being compulsory and free.

Like many other countries, Jordan's education system was heavily affected by the pandemic. All public and private schools were closed in mid-March 2020, affecting approximately 2.37 million students. Schools reopened for in-person learning at the start of the 2021–2022 academic year. During the closure, all students shifted to online learning using various digital tools and platforms.

2.2 Participants

The target population consisted of students enrolled in public and private schools in Jordan. From an estimated school population of 2,014,744 students (Department of Statistics, 2020), the study initially reached out to 3,000 students through teachers and parents in various districts. A total of 2,759 students from 12 districts completed the survey during the first week of May 2020.

Most participants attended public schools (93.6%). Approximately 75% of the respondents were female, and 25% were male. This imbalance is likely due to differential response rates during data collection, which relied on teacher and parent facilitation during a period of school disruption (May 2020). Similar patterns of higher participation among female students have been reported in survey-based studies. While this allowed for robust data collection, the gender distribution may limit the generalizability of the findings, particularly with respect to male students.

In terms of grade levels:

89% were in the primary stage, with 45% in the lower primary and 44% in the upper primary grades.

11% were in the secondary stage. These demographics allowed the study to capture a diverse range of student experiences in Jordan. The demographic characteristics of the respondents are presented in Table 1.

Table 1. Demographic Characteristics of the Study Sample (N = 2,759)

Characteristic	Category	n	%
School Type			
	Public	2582	93.6
	Private	177	6.4
Gender			
	Male	701	25.4
	Female	2058	74.6
Educational level			
	Lower primary (Grades 1-6)	1238	44.9
	Upper primary (Grades 7-10)	1207	43.7
	Secondary Grade (Grades 11-12)	314	11.3
Geographic Distribution			
	12 districts across Jordan	2759	100.0

The sample was predominantly from public schools (93.6%), reflecting Jordan's education system composition, where public schools serve approximately 72% of the national student population.

2.3 Data Collection Procedure

Data were collected in May 2020, several weeks after the students began learning fully online. Collecting data at this time allowed students to reflect on their experiences after engaging in remote learning for an extended period. This helped provide a clearer and more realistic picture of the challenges and opportunities encountered during the COVID-19 crisis.

Because schools were closed and movement was restricted during the quarantine, the researchers used the communication channels that were available at the time. A non-probability sampling strategy was used, combining purposive sampling and snowball sampling. At the start, teachers and parents from different regions of Jordan were purposively selected to ensure broad geographic representation. These initial participants were then asked to share

the survey with other teachers, parents, and students within their networks, creating a snowball sampling effect. This approach was practical and necessary because of lockdown conditions and heavy reliance on digital communication during the pandemic.

The survey link was shared with students through multiple online channels, such as messaging applications and parent–teacher groups, allowing students from different age groups, school types, and districts to participate. This supported the research team in gathering diverse perspectives and experiences from students across Jordan.

2.4 Data Collection Instrument

This study used a translated and adapted version of the survey developed by Owusu-Fordjour et al. (2020). The instrument was piloted and adjusted to ensure that it fit the Jordanian educational context. The survey aimed to capture students' views on the sudden move to online learning, their interaction with digital platforms, and the challenges they faced during the process.

A four-point Likert scale (strongly agree, agree, disagree, and strongly disagree) was used to encourage students to express a clear opinion rather than selecting a neutral option. Research on survey design supports this approach when measuring personal experiences, as it reduces the chances of selecting the midpoint without deep thinking (Dawes, 2008; Preston & Colman, 2000).

The survey included five dimensions that represented key areas of the online learning experience, such as student–teacher interaction, student engagement, technological readiness, access to digital resources, and overall effectiveness of online learning.

These dimensions were guided by the study's conceptual framework and aligned with established research on online and distance learning (Moore et al., 2011; Sun & Rueda, 2012).

2.5 Data Analysis

Survey data were analyzed using IBM SPSS Statistics (version 24). Descriptive statistics (frequencies and percentages) were calculated to summarize students' responses and address the three research questions: perceived effectiveness (RQ1), structural and instructional challenges (RQ2), and overall evaluations and preferences (RQ3).

Chi-square tests were used to examine differences in responses across student characteristics, such as gender, school type, and educational level. Statistical significance was set at $p < .05$. The dataset was checked for completeness prior to the analysis. The results are presented according to the research questions and interpreted considering the study framework.

3. Findings

The findings of this study are presented in response to three research questions examining Jordanian students' experiences during the emergency transition to online learning during the COVID-19 pandemic. It is essential to contextualize these results within the unprecedented nature of this shift: schools, teachers, and students transitioned to remote instruction with minimal preparation time, limited prior experience with online learning platforms, and no opportunities for systematic planning or infrastructure development. Therefore, the perceptions reported here reflect students' experiences under emergency remote learning conditions rather than within intentionally designed online educational environments.

RQ1: Effectiveness of the Transition from Face-to-Face to Online Learning

This research question examined students' views on the effectiveness of the shift from face-to-face learning to online learning during the COVID-19 school closures. Table 2 summarizes the student responses to seven key statements related to learning independence, resources, skills, interaction, and preferences.

Table 2 summarizes students' responses to seven statements covering independent learning, resources, technical skills, interaction, system effectiveness, and learning/communication preferences during emergency online learning

A large majority of students reported difficulty learning independently without teacher support, with 81.4% (n = 2,247) agreeing and 18.5% (n = 512) disagreeing with the statement. Students were divided on whether the online learning system effectively supported learning. Of the respondents, 47.7% (n = 1,315) agreed that the system was effective, while 52.3% (n = 1,444) disagreed. Many students reported that teacher contact supported their understanding of the material. A total of 60.3% (n = 1,663) agreed that direct contact with teachers helped them understand course concepts more clearly, compared with 39.7% (n = 1,096) who disagreed. Students also reported limitations in their home learning resources. Around 60.2% (n = 1,661) agreed that they did not have adequate resources at home to support

online learning, while 39.8% (n = 1,098) disagreed with this statement. When it comes to learning preferences, most students prefer studying at school to learning online. Of the respondents, 80.8% (n = 2,228) agreed with this statement, while 19.2% (n = 531) disagreed. Technical challenges were common. More than half of the students (63.6%; *n* = 1,756) agreed that they found it difficult to use the internet and online learning platforms for their studies, while 36.4% (n = 1,003) disagreed with this statement. Awareness of the Ministry of Education's online learning platform was relatively high, with 66.8% of students reporting moderate knowledge.

Students also reported a preference for using messaging platforms to communicate with teachers. Of the respondents, 67.1% *n*= 1,851) agreed that they preferred using direct messaging tools (e.g., WhatsApp or Facebook), compared with 32.9% (n = 908) who disagreed. A substantial proportion of students who demonstrated higher levels of digital readiness reported receiving teacher guidance on how to use online learning platforms before school closure. Specifically, 49% of students who felt digitally prepared indicated that their teachers had provided such guidance, compared with 51% who reported a lack of such guidance. This implies that teachers themselves were not fully prepared for the technical and pedagogical demands of the rapid transition. This pattern suggests a meaningful association between students' digital preparedness and the instructional support offered prior to the transition to online learning during the pandemic.

Overall, students reported the greatest difficulties in learning independently and showed a clear preference for studying at school rather than online learning. Many also indicated limited learning resources at home and challenges in using technology (Table 2). All response patterns were statistically significant ($p < .001$; Table 2).

Table 2. Student Perceptions of Online Learning Organized by Dimension (N = 2,759)

Dimension	Statements	Agree/Strongly Agree n (%)	Disagree/ Strongly Disagree n (%)	*p value
Learning Independence	I find it difficult to learn independently, without teacher support.	2247 (81.4)	512 (18.5)	< *.001*
System Effectiveness	The online learning system is effective in supporting students' learning.	1315 (47.7)	1444 (52.3)	< *.001*
Teacher Interaction	Direct contact with my teacher helps me understand course concepts more clearly	1663 (60.3)	1,096 (39.7)	< *.001*
Home Resources	I do not have adequate learning resources at home to support my online learning	1,661 (60.2)	1,098 (39.8)	< *.001*
Learning Preference	I prefer studying at school to learning online.	2,228 (80.8)	531 (19.2)	< *.001*
Technical Skills	I find it difficult to use the internet and online learning platforms for my studies	1,756 (63.6)	1,003 (36.4)	< *.001*
	I am aware of the online learning platform launched by the Ministry of Education for online learning	1843 (66.8)	916 (33.2)	< *.001*
Communication Preference	I prefer to communicate with my teacher through direct messaging platforms (e.g., WhatsApp or Facebook).	1,851 (67.1)	908 (32.9)	< *.001*
Digital Readiness	Teachers provided us with guidance on how to use online learning platforms before the school closure	1355 (49)	1404 (51)	< *.001*

* *P-values* are based on chi-square tests of response distribution (Agree vs. Disagree). All items were significant ($p < .001$).

RQ2: Structural and Instructional Challenges During Emergency Online Learning

This research question examined the structural challenges related to device access, internet connectivity, and time available for online learning. Table 3 summarizes the students' responses regarding their readiness for online learning. Most students reported using smartphones as their main device for online learning (2,498, 90.5%). Smaller proportions reported using laptops (163, 5.9%) or desktop computers (37, 1.3%) (Table 3).

Over half of the students reported having only one device available for e-learning (1,568; 56.8%), and 700 (25.4%) reported having two devices. Together, this indicates that 2,268 students (82.2%) had one or two devices available for e-learning (Table 3). Most students reported that more than one student in their household was using e-learning. Specifically, 1,837 (66.6%) reported that two to four students were using e-learning at home, and 562 (20.4%) reported more than four students (Table 3).

internet connection strength was a serious problem for most students. Only 521 students (18.9%) reported a good internet connection, while 1,350 (48.9%) reported moderate connectivity, and 888 (32.2%) reported weak connectivity (Table 3).

Table 3. Student's Responses Regarding Their Readiness for Online Learning During the COVID-19 Pandemic

Item	Response Options	n (%)
Average time spent using computer/internet daily for educational purposes		
	Less than 1 hour	474 (17.2)
	1–2 hours	759 (27.5)
	2–3 hours	529 (19.2)
	3–4 hours	399 (14.5)
	4–5 hours	233 (8.4)
	5–6 hours	123 (4.5)
	6–7 hours	90 (3.3)
	More than 7 hours	152 (5.5)
Device used for study		
	Smartphone	2498 (90.5)
	Computer	37 (1.3)
	Laptop	163 (5.9)
	Tablet/iPad	3 (0.1)
	Smartphone and laptop	2 (0.1)
	Television	5 (0.2)
Available devices for e-learning in the household		
	One device	1568 (56.8)
	Two devices	700 (25.4)
	Three devices	278 (10.1)
	More than four devices	213 (7.7)
Number of students using e-learning at home		
	One student	360 (13.0)
	Two to four students	1837 (66.6)
	More than four students	562 (20.4)
internet connection strength at home		
	Good	521 (18.9)
	Moderate	1350 (48.9)
	Weak	888 (32.2)

χ^2 tests indicated significant associations between device type, household device availability, and internet strength (all $p<0.001$).

Many students reported limited time spent daily on the educational use of the internet/computer, as 474 (17.2%) reported less than one hour per day. When combined, 1,762 students (63.9%) reported spending less than three hours per day on online learning (Table 3).

Overall, Table 3 indicates that students' readiness for online learning was shaped by patterns of smartphone reliance, limited device availability at home, shared access among multiple students in the household, and moderate-to-weak connectivity. Chi-square tests indicated significant associations between device type, device availability, and internet strength (all $p < .001$) (Table 3). In light of the reported device and connectivity patterns, students' communication preferences are presented in RQ3 below.

RQ3: Students' Overall Evaluation and Instructional Preferences

RQ3 builds on the findings from RQ1 and RQ2 by presenting students' overall evaluation of online learning and their preferences for learning modes and communication. While RQ1 described students' learning experiences and challenges, and RQ2 described access conditions at home, RQ3 summarizes how students evaluated online learning and what they preferred during the pandemic. As illustrated in Table 2, students' overall evaluations and preferences showed clear patterns across system effectiveness, learning modality preference, and communication preference. In Table 2, the strongest agreement is seen as preference for studying at school (80.8% agree), followed by preference for messaging apps (67.1% agree), while students are more divided on system effectiveness (47.7% agree vs. 52.3% disagree)

As shown in Table 2, students' overall evaluation of online learning was negative, with 52.3% disagreeing that the online learning system was effective. Students also reported a strong preference for studying at school rather than learning online (80.8% agreement). In addition, many students preferred communicating with teachers through direct messaging platforms such as WhatsApp or Facebook (67.1% agreement rate). These preferences are presented alongside the learning difficulties reported in RQ1 (e.g., independent learning and technical skills) and the access conditions in RQ2, such as smartphone reliance, moderate-to-weak internet connectivity, and limited time spent on online learning.

Overall, the findings show that many students reported difficulties with independent learning and using online platforms (RQ1), alongside access constraints such as heavy reliance on smartphones, limited devices at home, and moderate-to-weak internet connectivity (RQ2). In line with these patterns, students' overall evaluation of the online learning system was negative, most preferred studying at school, and many preferred using direct messaging tools to communicate with teachers (RQ3).

4. Discussion

This study explored the experiences of Jordanian students during the sudden transition to emergency online learning in May 2020. While online learning ensured continuity during school closures, the findings reveal a more complex reality: its effectiveness was constrained by the interaction of structural inequities, pedagogical limitations, and mismatches between institutional design and students' lived conditions. Rather than functioning as an equalizing solution, emergency online learning often reproduces, and in some cases intensifies, existing educational disparities.

The findings from all three research areas converge on a central thesis: meaningful student engagement in online learning is not solely contingent upon technological access. Rather, effective participation was predicated on the alignment between digital infrastructure, pedagogical strategies, and the conditions of the home learning environment. Therefore, it can be concluded that technological provision, in and of itself, is an insufficient condition for achieving equitable or effective educational outcomes. Without addressing this broader ecosystem of learning, digital reforms are likely to reproduce and even exacerbate the inequalities they are ostensibly designed to reduce.

Looking forward, especially as Jordanian schools begin to use artificial intelligence, these findings are critical. To avoid repeating the problems we saw with emergency online learning, plans must focus on more than just innovation. They need to be designed from the ground up to be fair, easy for everyone to use, and centered on great teaching.

4.1 Learning Demands and Student Readiness: The Challenge of Independent Learning

The first set of findings highlights substantial barriers to student readiness for online learning. Many learners were not adequately prepared for the demands of self-directed technology-mediated instruction. Difficulty learning independently, limited digital literacy, insufficient access to learning resources, and strong reliance on direct teacher guidance collectively point to a learning environment in which students struggled to adapt to the sudden shift to online learning.

These findings resonate with prior research showing that emergency remote teaching intensified the need for independent learning, digital competence, and self-regulation (Agarwal & Kaushik, 2020; Baber, 2020; Mukhtar et al., 2020). However, rather than simply confirming these patterns, the present study extends this body of work by demonstrating the scale and uniformity of these challenges in Jordan. While earlier studies often frame these skills as desirable competencies for successful online learning, our findings suggest that, in emergency conditions, they effectively became implicit prerequisites for participation—skills that many students had not previously developed and were not given the opportunity to acquire during the transition to online learning.

This distinction is important, as the existing literature tends to treat difficulties with self-regulation and digital learning as individual-level limitations or developmental gaps. In contrast, the findings of this study point to a systemic misalignment between instructional expectations and students' prior learning experiences. Jordanian students, like many learners in predominantly face-to-face systems, have been socialized into structured environments characterized by teacher-led instruction, immediate feedback, and closely guided learning processes. When these supports were abruptly withdrawn, students were not simply required to adapt; they were effectively repositioned as independent learners without the scaffolding necessary to support this transition.

In this sense, the challenge was not merely the absence of skills but also the absence of pedagogical mediation during the shift. As Mukhtar et al. (2020) suggest, emergency transitions often prioritize continuity of delivery over pedagogical adaptation. Our findings reinforce this concern by showing that the rapid move online transferred the responsibility for learning from the instructional system to the learner without corresponding changes in instructional design. This helps explain why difficulties with independent learning were so widespread: the issue was not whether students *could* learn independently but whether the system was designed to support them in doing so.

The strong emphasis students placed on teacher contact further underscores this. Consistent with Baber (2020), who highlighted the importance of instructor presence in shaping online learning experiences, our findings suggest that teacher interaction is not merely supportive but structural to understanding. Students did not simply miss access to information; they missed explanations, clarifications, feedback, and the adaptive responsiveness that characterizes effective teaching. Agarwal and Kaushik (2020) similarly noted that the absence of real-time instructional interaction can hinder comprehension, particularly in contexts where students rely on guided learning.

However, our study adds an important point: a teacher's presence is not only for instruction but also for connection. The absence of teacher interaction disrupted not only students' thinking but also their feelings about learning, such as their motivation, confidence, and reassurance. This aligns with the broader educational view that learning is a social process and not just an individual mental activity. From this perspective, the problems with emergency online learning were not just about technology; they reflect a deeper breakdown of human relationships that help us understand new ideas.

Taken together, these findings suggest that the challenges of online learning in this situation were not primarily technical but related to teaching methods and the educational structure. While digital platforms can provide access to content, they do not automatically provide the support, interaction, or guidance needed for real learning. Without a deliberate design that helps students develop independent learning skills and maintain meaningful teacher-student interaction, online environments risk demanding more from learners than they are prepared to give. This has important implications for future digital and AI-supported reforms in education, which must be designed not only to deliver content efficiently but also to support the developmental and relational conditions that make learning possible.

4.2 Structural Inequities and the Cascade Effect

The second set of findings underscores how deeply structural inequities shaped students' online learning experiences. Limited device access, heavy dependence on smartphones, and unstable internet connectivity did not function as independent barriers. Instead, they interacted in ways that compounded disadvantages and fragmented learning participation. For many students, learning became a negotiated process shaped by who had access to a device, when connectivity was available, and whether the platform could be used effectively under constrained conditions. This pattern reflects what UNESCO (2020) and related studies have described as the digital divide during the pandemic; however, the present findings suggest that its effects may be more interconnected and cumulative than often implied.

This is one of the clearest contributions of this study. While the existing literature has documented inequalities in access to devices and connectivity (UNICEF, 2020; Stelitano et al., 2020), these factors are often treated as discrete barriers. In contrast, the findings of this study indicate that they operate through a **cascade effect**, in which one constraint intensifies the impact of another. A student sharing a device with siblings already has reduced time for

engagement; when this is combined with unstable internet and reliance on smartphone interfaces, participation becomes even more fragmented. Small screens complicate navigation, interrupted connectivity reduces continuity, and household competition limits sustained attention. In this sense, the challenge is not simply the presence of multiple barriers but the way they interact to constrain learning in compounding ways. This interpretation extends earlier work by shifting the focus from access alone to the conditions under which access is practically usable.

This perspective also helps explain students' strong preference for face-to-face learning. As noted in previous regional studies (Alsoud & Harasis, 2021), connectivity challenges have been a recurring issue. However, the present findings suggest that these preferences are not merely attitudinal or nostalgic. Rather, they reflect a rational response to learning environments that are unstable and restrictive. When access is inconsistent and participation is fragmented, face-to-face instruction becomes a more reliable and effective alternative.

The same logic applies to the limited engagement time. Reduced study hours should not be automatically interpreted as evidence of low motivation or poor time management. As highlighted in broader pandemic-related research (UNESCO, 2020), structural constraints often shape the participation patterns. In this study, prolonged engagement was frequently difficult to sustain because access was intermittent, negotiated, and technologically fragile. For some students, especially those with the most constrained conditions, limited engagement time may reflect structural limitations rather than individual disengagement.

Seen in this light, the digital divide is not simply about having or not having internet access. It is about how material constraints shape the depth, continuity, and quality of their participation. This reframing is important because it shifts the focus away from individual responsibility and toward the structural conditions under which learning becomes possible or is constrained. In doing so, it aligns with and extends existing research by emphasizing that equity in online learning depends not only on access but also on the stability, usability, and distribution of that access in everyday learning contexts.

4.3 The Platform–Practice Mismatch: Institutional Design and Student Realities

The third finding highlights a clear disconnect between the digital platforms institutions relied on and the communication practices that were most accessible and intuitive to students. As shown in Table 2, many learners gravitated toward informal, mobile-friendly tools such as WhatsApp and Facebook because these platforms aligned more closely with their everyday digital habits and the constraints of their available technology. This preference reflects more than convenience; it points to a structural misalignment between institutional expectations and students' actual access conditions.

While formal learning platforms are typically designed for stable connectivity and desktop-based use, students in this study primarily engaged through smartphones and often under conditions of intermittent access. In this context, official platforms were frequently experienced as difficult to navigate, whereas messaging applications offered immediacy and flexibility. This pattern is consistent with the findings reported by Al Bataineh et al. (2021) and Al-Salman and Haider (2021); however, the present results suggest that these preferences are not simply behavioral but are shaped by underlying technological constraints. In other words, the choice of platform reflects what is usable in practice, not merely what is available.

This platform–practice mismatch has direct implications for engagement. Even when instructional content was available, participation was limited if students could not interact with the platform effectively. Consequently, the issue is not only one of access but also of alignment between system design and user conditions. This extends earlier work by highlighting that institutional platform, when designed without considering mobile use and bandwidth limitations, may unintentionally create barriers to participation.

The implications of equity are significant. Platform selection is not a neutral technical decision; it shapes who can engage consistently and meaningfully in learning activities. In contexts where smartphone use is predominant, adopting mobile-responsive, low-bandwidth, and simplified platform designs is essential. Without such alignment, systems intended to support learning risk excluding the students they are meant to serve.

4.4 Overall Evaluation and Student Preferences: The Effectiveness–Comprehension Gap

Taken together, students' evaluations of online learning were formed under conditions of constrained access, platform friction, and routine disruption. Within this context, students tended to gravitate toward tools and practices that were immediate and workable in their everyday experiences. The correlation pattern suggests three observations. First, familiarity with platforms appears to shape perceptions of effectiveness; when systems are easy to navigate, students are more likely to evaluate them positively. Second, teacher guidance functions as an important pedagogical scaffold, helping students understand both content and platform use. Third, household resource constraints continue

to influence preferences, often reinforcing a preference for face-to-face learning, where such constraints are less limiting.

These findings are broadly consistent with prior research in Jordan and similar contexts, which reported a general preference for traditional in-person learning and lower perceived effectiveness of online alternatives under constrained conditions (Adnan & Anwar, 2020; Al Salman & Haider, 2021; Toubasi et al., 2022). However, the present study revealed a more complex pattern. Despite reporting considerable challenges with independent learning, access, and usability, a notable proportion of students viewed online learning as effective.

This apparent tension points to what can be described as an effectiveness–comprehension gap, wherein students' evaluations of effectiveness do not fully correspond to their reported learning experiences. Rather than indicating inconsistency, this suggests that students may have drawn on broader criteria in forming their judgments, such as the continuity of schooling during the crisis or the perceived legitimacy of formal instruction, even while encountering difficulties in understanding and engagement with the material.

Several interpretations are possible for this finding. Students with limited prior exposure to online learning may lack a clear benchmark for evaluating its effectiveness. Simultaneously, responses may have been influenced by contextual factors, including the tendency to evaluate the system positively during a period of disruption. More importantly, the findings may reflect a limited distinction between participation and learning; activities such as logging in, viewing materials, or submitting assignments may have been interpreted as indicators of success, even when a deeper understanding was not achieved.

This interpretation extends earlier studies that tend to frame student perceptions in binary terms (positive or negative). In contrast, the present findings suggest that students can simultaneously perceive online learning as functioning while struggling with the core learning processes. This has important implications for the assessment of effectiveness. Reliance on self-reported satisfaction or perceived effectiveness alone may overlook the underlying challenges related to comprehension and engagement. Therefore, more comprehensive evaluation approaches, including formative assessments and evidence of learning outcomes, are necessary to capture the quality of online learning more accurately.

4.5 The Role of Support Systems: Necessary but Insufficient here

While structural barriers dominated students' experiences, support systems, or their absence, also shaped learning outcomes in important ways. Parental support was widespread, with 77.0% of students reporting it; however, this support was often insufficient to overcome broader systemic challenges. Many parents, particularly those with limited formal education or digital literacy, struggled to provide academic assistance with complex subject matter. The limited availability of supplementary support, such as tutoring, further constrained students' options, leaving those who were already struggling with few avenues for additional help. In this context, the absence of sustained academic support likely contributed to widening achievement gaps, particularly among students who reported difficulty in understanding complex concepts online.

This finding aligns with Putra et al. (2020), who emphasized the importance of parental involvement during emergency remote learning. However, the present results suggest a more qualified interpretation of this finding. While parental support is valuable, it does not function as an adequate substitute for key elements of the learning system, including infrastructure, platform usability, instructional design, and teacher preparedness. In this sense, parental involvement appears to mediate learning experiences rather than compensating for systemic limitations. This distinction is important because it highlights how the effectiveness of support systems is shaped by broader structural conditions in the country.

The limitations of parental support also reflect the underlying inequalities in social and cultural capital. Families with higher education levels, greater economic resources, and more flexible work arrangements were better positioned to assist their children, while others faced constraints that limited their ability to provide sustained academic support. Consequently, support systems may have unevenly benefited students, potentially reinforcing existing disparities rather than reducing them.

Teacher preparation is an equally critical factor. Students' responses indicated that fewer than half felt adequately prepared by their teachers, pointing to a systemic issue rather than isolated instructional gaps in the curriculum. This rapid transition required teachers to redesign their instruction, adopt new technologies, and support students in unfamiliar environments, often with limited time, training, or institutional guidance.

This situation reflects a broader pattern noted in the literature. Aliyyah et al. (2020) highlight the challenges teachers faced in adapting to online instruction, while Babinčáková and Bernard (2020) point to the loss of traditional

instructional tools and the need for new forms of scaffolding. Similarly, Alkhwaja and Seitan (2022) emphasize how compressed timelines during crisis-driven transitions intensified these challenges. The present findings build on this work by showing how these constraints were experienced from the students' perspective, particularly in relation to the clarity of instruction and preparedness for platform use.

Taken together, these findings suggest that support systems are necessary but insufficient. Parental involvement and teacher effort play important roles, but they cannot fully compensate for gaps in infrastructure, preparation, and system design. This points to the need for a more integrated approach to support, one that includes sustained investment in teacher digital competence, pedagogical training, and institutional preparedness to ensure that future transitions can support both effective teaching and meaningful learning.

4.6 Government Response and Policy Implementation: Infrastructure Without Prerequisites

The Jordanian government's rapid introduction of online platforms and dedicated television channels demonstrated a clear commitment to maintaining educational continuity during the crisis (Kutieshat & Farmanesh, 2022). These initiatives reflect proactive policymaking and an understanding of the need for immediate alternatives during school closures. However, the findings suggest that their effectiveness is constrained by challenges in implementation and alignment with students' learning conditions.

The limited use of television-based instruction is particularly illustrative of this. Although such approaches may expand, they offer minimal opportunities for interaction, personalization, or feedback. Consequently, they provide limited support to students who require clarification, guidance, and ongoing engagement. In this sense, the unidirectional nature of broadcast media does not align well with the relational and interactive dimensions of learning identified earlier in this study.

More fundamentally, the government response appears to have prioritized the provision of delivery mechanism platforms and broadcast channels without fully addressing the prerequisites necessary for their effective use. These include access to devices, reliable connectivity, teacher training, student digital literacy, and appropriate pedagogical adaptations. This reflects a broader pattern in educational technology implementation, where the availability of infrastructure is assumed to translate into meaningful usage.

The present findings suggest that this assumption does not hold under such constrained conditions. Consistent with the structural inequities and platform mismatches discussed in earlier sections, access to platforms alone does not ensure participation, engagement, or understanding. Instead, the effectiveness of these initiatives depends on the extent to which they align with students' actual learning environments and capacities.

This has important implications for future policies. Technology should be understood as a component of a broader educational ecosystem rather than a standalone solution. Therefore, effective policy must address not only infrastructure but also access conditions, user readiness, instructional design, and ongoing support. Without these elements, technological interventions risk functioning as mere symbolic responses rather than effective educational strategies.

The findings point to a central insight: the effectiveness of emergency online learning was shaped less by the presence of technology than by the alignment between technology, pedagogy, and students' lived experiences. Students struggled not because they were resistant to online learning but because they were required to learn independently without preparation, participate without reliable access, and engage through platforms that did not reflect their actual technological realities. Therefore, this study offers an integrated account of emergency online learning, linking learner readiness, structural inequality, platform design, support systems, and policy response within a single explanatory framework. As education systems move beyond crisis response toward longer-term digital and AI-enabled reform, these findings highlight the importance of designing innovations around equity, usability, and meaningful learning, rather than if technological provision alone will lead to effective outcomes.

4.7 AI and Equity Recommendations

As education systems increasingly adopt AI-supported tools, such as adaptive learning platforms, tutoring chatbots, automated feedback systems, and generative AI, equity must remain at the center of policy and practice. AI has the potential to enhance learning, but it can also deepen existing divides when students lack reliable devices, stable internet connectivity, or the digital skills needed to use these tools effectively. International guidance, including UNESCO's principles for generative AI and OECD's work on AI in education, emphasizes equitable access, strong governance, human-centered design, and robust privacy protections as essential conditions for avoiding harm and exclusion.

The patterns observed in this study; heavy reliance on smartphones, limited household devices, unstable connectivity, and widespread platform challenges, mirror the same structural conditions that will shape AI readiness today. In this sense, equity in AI adoption is not a future concern; it is an extension of the digital inequities documented in 2020.

5. Implications

To ensure AI integration supports all learners rather than widening opportunity gaps, current policy should prioritize several key areas:

First, AI access equity must be treated as a prerequisite and not an afterthought. AI tools should be selected and designed with students' contexts in mind, including compatibility with mobile devices, functionally under low-bandwidth conditions, and the availability of non-AI or offline alternatives for those with limited access. Without such considerations, AI risks becoming another barrier rather than a bridge.

Second, *AI literacy should be systematically developed among students.* Students need structured guidance on using AI responsibly, including the ability to critically evaluate outputs, verify information, avoid over-reliance, and understand both the capabilities and limitations of AI systems. These competencies are becoming foundational for equitable participation in digital learning ecosystems.

Third, *sustained teacher professional development is critical.* Educators need ongoing support to integrate AI effectively into instruction, assessment and feedback. Training should extend beyond technical use to include ethical considerations, the design of integrity-preserving assessment, and approaches that ensure AI complements rather than replace human interaction.

Fourth, *clear governance, privacy, and safeguarding frameworks must be established.* Education systems should implement approval mechanisms for AI tools, define data protection standards, and articulate expectations for responsible use in teaching and assessment. Transparent policies are critical to protecting students, particularly those most vulnerable to data misuse or algorithmic bias.

Finally, *the impacts of AI adoption should be monitored through an equity lens.* Schools and ministries should track whether AI-supported learning benefits all students or disproportionately advantages those with stronger home resources, better connectivity, or prior digital experience. Equity monitoring ensures that AI adoption reduces, not amplifies, systemic disparities.

In summary, integrating AI into education must be guided by the core lesson of this study:
digital access is inseparable from digital opportunity.

Just as inequities shaped students' experiences of online learning during the pandemic, they will shape who benefits from AI today. Ensuring equitable access, literacy, readiness, and governance is therefore essential for AI to serve as a tool for inclusion rather than a driver of widening educational divides.

6. Limitations

This study has several limitations that should be considered when interpreting its findings. Because the data were collected at a single early moment in the pandemic, the results capture students' immediate reactions rather than how their experiences evolved as schools, families, and teachers adapted over time. The reliance on self-reported perceptions, while valuable for understanding students' viewpoints, may omit important nuances related to actual learning outcomes or household circumstances, and future work would benefit from triangulating surveys with teacher insights, parent perspectives, and learning analytics. In addition, although the sample was large and geographically varied, the online survey format may have unintentionally excluded students facing the most severe access barriers, introducing potential selection bias. The absence of detailed information on socioeconomic background, prior achievement, or special learning needs also limits our ability to examine how different groups were differentially affected. Finally, the study centers student voices without incorporating data from other stakeholders, and a more holistic, multi-actor approach would deepen understanding of the complex ecosystem that shaped emergency online learning.

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Appendix

A copy of the online survey adopted from Owusu-Fordjour et al. (2020)

(1) I am able to study effectively from the house during the Covid-19 lockdown.

(2) Online learning alone makes it difficult to get some concepts explained.

(3) There is an Internet access in my area to enable me to learn using my phone or laptop.

(4) The online system of learning is very effective and will help many students.

(5) Having contact with teachers make it easier for them to explain concepts better to me so that I can understand them.

(6) I have better ICT skills to be able to access other online learning platforms.

(7) I am aware of the online learning platform launched by the Ministry of Education.

(8) Our teachers gave us orientation on the use of e-learning.

(9) We had online platforms prior to the school closedown.

(10) My parents can teach me how to use the Internet at home, so that I can learn.

(11) My parents supervise my learning at home without any difficulties.

(12) I have a private teacher who visits to teach me even when the school is closed down.

(13) I do not have adequate learning resources in the house to aid my learning.

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Data sharing statement

No additional data are available.