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Research Article

Teachers' Digital Practices in Tunisia: Structural Constraints and Contextual Adaptation in Schools

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Abstract
The integration of digital technologies is an important priority in Tunisian educational reforms. However, their use in public secondary schools remains constrained by infrastructural, institutional, and professional challenges. This study examines how Tunisian secondary school teachers use digital technologies and adapt their practices to local conditions. It explores the main constraints affecting ICT integration and the strategies teachers develop to address them. A qualitative approach was adopted, combining semi-structured interviews and classroom observations with secondary school teachers from different regions of Tunisia. The data were analyzed through thematic coding, focusing on technological access, institutional support, professional development, and pedagogical practices. The findings reveal persistent challenges, including inadequate infrastructure, unequal access to digital resources, technical difficulties, and limited opportunities for continuous training. Despite these constraints, teachers demonstrate professional agency and adaptability through collaboration, resource sharing, use of freely available digital materials, and flexible adaptation of available technologies to classroom needs. These practices indicate that teachers actively reinterpret and adapt digital policies rather than simply implementing them. The study concludes that ICT integration in Tunisian secondary schools results from the interaction between structural constraints and teacher agency. Sustainable digital integration requires improved infrastructure, stronger institutional support, and continuous professional development. Recognizing teachers' contextual knowledge and adaptive practices is also essential for developing effective and context-sensitive digital education policies in Tunisia.

Keywords: Classroom Innovation, Digital Pedagogy, ICT Integration, Professional Agency, Structural Constraints, Tunisia

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1. INTRODUCTION

The progressive incorporation of digital technologies into education reflects a broader transformation of contemporary teaching and learning systems. Across many countries, educational reforms increasingly rely on digitalization as a means of supporting pedagogical renewal, strengthening the modernization of schools, and developing students' digital competences (OECD, 2015; UNESCO, 2023). Digital technologies are therefore frequently associated with the prospect of enhancing the quality of education, providing more individualized learning experiences, and facilitating access to educational resources. Nevertheless, the implementation of digital technologies does not necessarily produce uniform or immediate improvements in educational practices. Their effects are shaped by a complex interaction between institutional environments, available resources, organizational arrangements, professional cultures, and teachers' ability to incorporate digital tools meaningfully into their work (Selwyn, 2016).

Research conducted in different educational contexts has consequently drawn attention to the discrepancy that may exist between official narratives surrounding digital transformation and the realities observed in schools. Although national and international policies often present digital technologies as powerful instruments for educational change, their classroom implementation may remain partial, uneven,

or primarily instrumental. Limited infrastructure, insufficient technical support, organizational constraints, and established professional routines can restrict the pedagogical use of digital resources (Cuban, 2001; Fullan, 2013). Digitalization should therefore not be understood solely as a technological process but rather as a multidimensional transformation influenced by the social and professional conditions in which technologies are introduced.

From this perspective, teachers constitute a key component of any process of digital educational transformation. Their professional practices, pedagogical conceptions, level of technological competence, and perceptions of the educational value of digital tools all contribute to determining how technologies are actually used in classrooms (Ertmer & Ottenbreit-Leftwich, 2010; Tondeur et al., 2017). Investigating digital education therefore requires moving beyond questions of technological provision to examine the concrete practices through which teachers select, adapt, and integrate digital resources within their instructional activities.

Particular attention should also be given to the strategies developed by teachers when they encounter material, institutional, or organizational limitations. Such adaptive practices can reveal how educational professionals negotiate the gap between prescribed digital policies and the conditions of everyday school life. Studying these experiences makes it possible to better understand the mechanisms through which digital innovation emerges in contexts where resources and institutional support may be unevenly distributed. It can also provide evidence for designing educational policies that are more responsive to local realities and better equipped to address persistent forms of digital inequality. Accordingly, examining teachers' lived experiences and everyday uses of digital technologies offers an important perspective for understanding the actual dynamics of educational digitalization. Rather than considering technology as an autonomous driver of change, this perspective emphasizes the interaction between technological resources, professional agency, institutional conditions, and pedagogical practices. Such an approach is particularly relevant for identifying realistic and sustainable forms of digital transformation in educational systems facing structural and contextual constraints.

1.1. Global Context of Digital Transformation in Education

The widespread adoption of digital technologies has progressively become a major issue for educational systems, attracting increasing attention from policymakers, researchers, and practitioners across the world. Over recent decades, information and communication technologies (ICT) have increasingly been regarded as instruments capable of reshaping educational practices by facilitating access to learning resources, supporting student participation, encouraging collaborative activities, and contributing to the development of digital competencies needed in contemporary knowledge societies (UNESCO, 2023; OECD, 2015). Beyond their instructional functions, digital technologies have also been incorporated into broader educational agendas concerned with modernization, innovation, inclusion, and lifelong learning. In numerous educational systems, digitalization has consequently been incorporated into reform strategies intended to respond to major societal and economic changes. Schools are increasingly expected to make use of digital learning environments, educational platforms, multimedia resources, and blended or hybrid teaching arrangements. These developments are generally intended to expand the range of pedagogical possibilities while encouraging learners to become more autonomous and active in their learning processes. The outbreak of the COVID-19 pandemic considerably intensified this transformation. The sudden closure of educational institutions required schools and universities in many parts of the world to adopt remote and online teaching mechanisms within a very limited period (Hodges et al., 2020). This experience highlighted the importance of digital infrastructures and platforms in maintaining educational activities when conventional face-to-face instruction became temporarily impossible.

Nevertheless, the international literature indicates that the presence of digital technologies alone does not guarantee substantial changes in teaching practices or improvements in students' learning. Their educational value is strongly conditioned by the interaction of several factors, including institutional arrangements, pedagogical traditions, teachers' professional competencies, school leadership, available resources, and socio-economic circumstances (Selwyn, 2016). In this respect, technological provision should not be equated with effective digital integration. Cuban (2001), for example, demonstrates that the introduction of technological equipment into schools may coexist with relatively traditional forms of teaching, particularly when teachers lack the conditions or support required to transform their pedagogical

practices. A considerable distance may therefore remain between the objectives formulated in digital education policies and the conditions encountered in schools. While governments and international organizations frequently regard ICT as an instrument for improving educational quality and promoting greater inclusion, many institutions continue to experience significant difficulties related to infrastructure, Internet reliability, access to appropriate digital resources, technical assistance, and continuous professional development for teachers (Fullan, 2013). Such disparities can result in markedly different levels of digital adoption across countries, geographical areas, schools, and social groups. Consequently, digitalization may, under certain conditions, contribute to reproducing or even intensifying pre-existing educational inequalities rather than automatically reducing them. The expansion of digital technologies also raises broader questions about the pedagogical, ethical, and social dimensions of educational change. Increasing attention is therefore being given to the limitations of approaches that treat technological innovation as an end in itself. A more contextualized perspective requires consideration of the individuals and professional communities responsible for transforming technological possibilities into educational practices.

Teachers occupy a particularly important position in this process because their pedagogical beliefs, technological knowledge, professional experience, and ability to adapt to changing circumstances influence the ways in which digital resources are selected and used in classroom settings (Ertmer & Ottenbreit-Leftwich, 2010). From this standpoint, the digital transformation of education should be viewed as a multidimensional process rather than as a simple technological transition. Its development depends on the articulation of technological resources with institutional policies, organizational conditions, professional cultures, and classroom practices. Understanding this transformation therefore requires examining not only the availability of digital technologies but also the contextual factors that determine how educational actors appropriate, adapt, and integrate them into their everyday professional activities.

1.2. Theoretical Perspectives on Teachers' Digital Practices

The educational use of digital technologies cannot be understood simply in terms of providing teachers and students with technological equipment. When digital tools become part of classroom activities, they may influence the way lessons are designed, knowledge is presented, interactions are organized, and learning is assessed. Digitalization consequently involves changes in teachers' professional practices as well as in their understanding of teaching and learning. One of the most influential frameworks for examining these practices is the Technological Pedagogical Content Knowledge (TPACK) model proposed by Koehler and Mishra (2009). This framework considers effective technology integration as the result of an interaction between three main areas of teacher knowledge: technological, pedagogical, and content knowledge. The model consequently moves beyond a purely technical conception of digital competence. Knowing how to operate a digital tool is not sufficient; teachers also need to determine whether, how, and for what pedagogical purpose that tool can be integrated into a particular subject and learning situation. Digital competence can therefore be viewed as a situated professional capacity in which technological choices are connected to pedagogical objectives and disciplinary content.

Teachers' attitudes and professional beliefs also play an important role in determining how technologies are used. Ertmer and Ottenbreit-Leftwich (2010) emphasize that teachers' beliefs, confidence, perceived competence, and attitudes toward technology can either facilitate or constrain the development of digital practices. Teachers who recognize educational value in digital tools and feel sufficiently prepared to use them are generally more willing to experiment with new practices. By contrast, insufficient training, limited time, organizational pressures, technical difficulties, and inadequate institutional support can restrict their willingness or ability to integrate technology meaningfully. This perspective also changes the way teachers are positioned within educational reforms. Rather than simply applying digital policies designed at institutional or governmental levels, teachers actively interpret and adapt these policies to their own professional environments. Their choices are influenced by classroom needs, available resources, previous experience, professional identity, and the expectations of their institutions. Digital practices should therefore be understood as the outcome of continuous negotiation between prescribed objectives and the realities of everyday teaching. This situated perspective is particularly relevant for understanding why similar technologies may lead to very different practices from one school or teacher to another.

Another important dimension concerns inequalities in digital education. The digital divide is not limited to differences in access to computers, mobile devices, or Internet connectivity. It also encompasses

differences in the ability to use digital technologies effectively and in the benefits that individuals and educational institutions are able to derive from them. Earlier research already distinguished between inequalities of access and inequalities in the ways technologies are used (Pelgrum, 2001; Voogt & Knezek, 2008). From an educational perspective, these disparities may appear through unequal opportunities for teacher training, differences in institutional support, variations in digital competence, and contrasting capacities to develop innovative pedagogical practices. These inequalities become particularly visible in educational environments where technological and institutional resources are limited. In such circumstances, teachers may rely on practical adjustments to maintain their teaching activities. They may share resources with colleagues, develop informal forms of professional collaboration, select freely available digital materials, or modify existing tools according to local constraints. Such practices demonstrate that teachers are not merely constrained by their environments; they can also exercise professional agency by developing solutions adapted to the conditions in which they work.

Taken together, these theoretical perspectives suggest that teachers' digital practices result from the interaction of several dimensions rather than from technological availability alone. Technological knowledge, pedagogical expertise, disciplinary requirements, professional beliefs, institutional conditions, and teachers' capacity to adapt all contribute to shaping digital integration. Examining these dimensions simultaneously provides a more comprehensive understanding of how digital transformation is experienced in schools and how teachers appropriate, modify, or sometimes limit the use of digital technologies according to their professional and contextual realities.

1.3. ICT Integration in Tunisia: Constraints and Contextual Realities

The development of digital education has been part of Tunisia's educational agenda for several decades. Since the beginning of the 2000s, successive reforms have sought to introduce information and communication technologies (ICT) into schools with the aim of modernizing educational provision, diversifying teaching practices, and preparing learners for the demands of an increasingly digital society. More recent national and international policy frameworks continue to emphasize digital competence and the digital transformation of education as important components of educational development in Tunisia (UNESCO, 2023; World Bank, 2022). Nevertheless, the implementation of these orientations remains uneven, particularly within public secondary schools, where teachers and learners do not always benefit from the conditions required for sustained digital use. One of the main difficulties concerns the unequal material conditions available to schools. Access to reliable Internet connections, functional computers, appropriate digital equipment, and technical maintenance remains variable across institutions. Differences can also be observed between geographical areas, with schools in some rural or disadvantaged settings facing greater difficulties in accessing technological resources than better-equipped institutions. In addition, the presence of equipment does not necessarily mean that it is available for regular classroom use. Devices may be obsolete, insufficient in number, or inadequately maintained. Such disparities can affect students' opportunities to benefit from digital learning and may reproduce existing territorial and social inequalities (Trabelsi & Rezgui, 2020; UNESCO, 2023).

The challenges are not exclusively technological. Teachers' professional preparation and the organizational environment of schools also influence the extent to which ICT can become part of everyday teaching. Opportunities for sustained professional development in digital pedagogy remain an important issue, particularly when training focuses mainly on technical skills without sufficiently addressing teachers' pedagogical needs. Limited time, workload, insufficient technical assistance, and the absence of continuous institutional support can further discourage experimentation with unfamiliar digital practices (Trabelsi & Rezgui, 2020). Teachers' level of digital competence and their confidence in using technology are consequently important factors in determining whether available tools are transformed into meaningful pedagogical resources (Tondeur et al., 2021; Redecker, 2022). The organization of teaching itself can constitute another obstacle. Established pedagogical traditions, demanding curricula, large numbers of students in some classrooms, and assessment practices that continue to favor conventional forms of instruction may restrict opportunities for technology-supported, collaborative, or learner-centered activities. Under such conditions, teachers may use digital tools primarily to support existing teaching routines rather than to redesign the learning process. This observation reinforces the idea that educational digitalization cannot be achieved through technological provision alone. Institutional support, professional

development, pedagogical flexibility, and an organizational culture favorable to experimentation are also necessary conditions for sustainable innovation (Fullan, 2020; Ertmer et al., 2022).

The COVID-19 crisis provided a particularly revealing illustration of these difficulties. The sudden interruption of face-to-face schooling required Tunisian teachers to establish alternative forms of communication and instruction within a very short period. The transition to remote teaching exposed differences in access to devices, Internet connectivity, digital platforms, and previous experience with online learning. It also placed additional demands on teachers, many of whom had to acquire new digital practices while simultaneously maintaining contact with their students (Hodges et al., 2020). More broadly, international evidence from the pandemic showed that education systems with limited technological and institutional resources were especially vulnerable to disruptions affecting digital learning (OECD, 2021; UNICEF, 2022). In response to these circumstances, Tunisian teachers developed a range of practical solutions. Personal smartphones and computers were frequently used alongside readily accessible communication applications and online platforms. Social media and messaging services, including Facebook, Messenger, and WhatsApp, could serve as supplementary channels for sharing educational materials, communicating with students, and organizing learning activities. In some cases, teachers also relied on informal collaboration with colleagues to exchange resources and develop solutions to technical or pedagogical difficulties. These practices illustrate the capacity of teachers to adapt existing technologies to local circumstances when formal institutional arrangements are insufficient (Bozkurt et al., 2020; Dhawan, 2020).

The Tunisian case consequently demonstrates that digital transformation is shaped by the interaction between policy objectives and the concrete conditions in which teachers work. National strategies may promote ambitious goals for educational digitalization, but their implementation depends on infrastructure, professional preparation, institutional support, and the socio-economic characteristics of schools and learners. Teachers occupy a particularly important position within this process because they mediate between technological possibilities and classroom realities through their professional choices and adaptive practices. Accordingly, examining ICT integration in Tunisia requires attention to both structural constraints and teachers' capacity to respond creatively to them. A sustainable approach to digital education should therefore move beyond the provision of equipment and consider the wider ecosystem in which technology is used. Strengthening infrastructure, improving continuous professional development, providing reliable technical support, and taking account of differences between schools and regions are essential for developing a more equitable and context-sensitive digital education strategy (UNESCO, 2023; World Bank, 2022).

1.4. Research Objectives and Scientific Contribution

Against the background described above, this study examines how teachers in Tunisian public secondary schools use and adapt digital technologies in their professional practice. Particular attention is given to the tension between the conditions imposed by the educational environment and the practical solutions developed by teachers in response to these conditions. The study is based on the premise that digital practices cannot be separated from the contexts in which they emerge. They are influenced by institutional arrangements, professional cultures, material resources, and teachers' capacity to exercise agency in their everyday work (Tondeur et al., 2017; Selwyn, 2022). The research therefore moves away from a view of teachers as merely implementing technological initiatives designed by educational authorities. Instead, teachers are considered active participants in digital transformation who interpret institutional expectations and adapt available technologies to the needs of their classrooms. The central aim is to understand how they appropriate and use digital resources when confronted with material, organizational, and institutional limitations. More specifically, the study seeks to:

1. Identify the main structural, institutional, and pedagogical factors that hinder the integration of ICT in Tunisian public secondary schools;
2. Examine the strategies teachers develop to deal with limited technological resources and organizational difficulties;
3. Investigate how context-specific forms of pedagogical innovation emerge under conditions of limited resources;

4. Understand how teachers experience, interpret, and negotiate digital transformation in their everyday professional activities.

To address these objectives, the research adopts a qualitative design based on semi-structured interviews and classroom observations. This methodological orientation makes it possible to access teachers' experiences, perceptions, and practices while taking into account the particular circumstances in which these practices occur. Qualitative inquiry is especially appropriate for studying educational change because it allows researchers to examine processes, meanings, and interactions that may not be adequately captured through quantitative indicators alone (Creswell & Poth, 2018). The scientific contribution of the study can be considered from several perspectives. First, it contributes to current discussions on educational digitalization by shifting attention from the mere availability of technological resources toward the conditions under which teachers actually use them. By focusing on professional agency and contextual adaptation, the study complements approaches that primarily examine infrastructure, policy implementation, or technological access (UNESCO, 2023; OECD, 2021). It thus emphasizes the distinction between having access to digital technologies and being able to transform them into useful pedagogical resources.

Second, the research contributes to the discussion of digital inequalities. Differences in digital education are not exclusively related to whether teachers and students possess appropriate devices or Internet connections. They may also concern the quality of professional training, access to institutional assistance, teachers' confidence and competencies, and the pedagogical opportunities available for using digital resources (Redecker, 2022; Selwyn, 2022). From this perspective, digital inequality is understood as a multidimensional phenomenon extending from technological access to the capacity to make meaningful educational use of technology. Third, the study adds empirical evidence concerning the Tunisian educational context, which remains less represented in the international literature on teachers' digital practices and ICT integration in secondary education. Examining public schools in Tunisia makes it possible to explore how broad international and national digitalization agendas are interpreted and reshaped within specific institutional, socio-economic, and material conditions. The study consequently provides insight into the ways global educational trends acquire locally specific forms.

Finally, the research has implications for educational policy and professional development. Its findings are expected to underline the importance of sustained teacher training, accessible technical support, institutional collaboration, and working conditions that allow educators to experiment with digital approaches. Supporting teachers should therefore not be limited to providing technological equipment. It should also involve creating an environment in which they can develop their professional competencies, exchange practices, and adapt digital resources to the realities of their classrooms (Ertmer et al., 2022; Fullan, 2020). Overall, this research views digital transformation as an ongoing process rather than a one-time technological intervention. Its sustainability depends on the interaction between technological resources, institutional support, teacher agency, and local educational realities. By placing teachers' experiences at the center of the analysis, the study seeks to contribute to a more contextualized understanding of digital transformation and to the development of educational policies that are both more equitable and more responsive to the realities of Tunisian schools.

1.5. Research Questions

In light of the growing importance of digital transformation in education and the persistent challenges surrounding ICT integration in Tunisian public secondary schools, this study seeks to examine how teachers experience, negotiate, and implement digital practices within contexts characterized by material and institutional constraints. Although educational policies increasingly promote the integration of digital technologies as a lever for pedagogical modernization and educational innovation, important disparities continue to shape the realities of ICT use in schools, particularly in resource-constrained environments (UNESCO, 2023; Selwyn, 2022). Within this perspective, the present research is guided by the following research questions:

1. What are the main structural, institutional, organizational, and pedagogical constraints affecting the integration of digital technologies in Tunisian public secondary schools?

2. How do teachers appropriate, adapt, and mobilize digital technologies in their pedagogical practices despite these contextual constraints?

These research questions aim to provide a deeper understanding of the complex relationships between institutional conditions, material limitations, professional cultures, teacher agency, and everyday pedagogical practices. More specifically, the study seeks to explore how teachers develop adaptive strategies, informal practices, and situated forms of pedagogical innovation in order to ensure pedagogical continuity, maintain student engagement, and respond to the demands of digital transformation within constrained educational environments. By focusing on teachers' lived experiences and professional practices, this research also intends to contribute to broader reflections on educational change, digital inequalities, and the social dimensions of technological integration in schools. In this regard, the study emphasizes that digital transformation cannot be understood solely as a technical or infrastructural process, but rather as a situated educational and social dynamic shaped by contextual realities, institutional support, and teachers' professional capacities (Tondeur et al., 2021; Redecker, 2022). The study therefore pays particular attention to the ways in which teachers transform constraints into practical opportunities for action. It also considers how these situated experiences may inform more sustainable and context-sensitive approaches to digital education in Tunisia. Finally, the findings are expected to provide empirical evidence that can support future educational policies and teacher professional development initiatives.

2. METHODOLOGY

2.1. Research Design

The study was designed as a qualitative inquiry with an interpretive orientation, focusing on the ways teachers understand and enact digital practices in Tunisian public secondary schools. This methodological choice was motivated by the need to access participants' experiences, interpretations, and practical responses to the challenges associated with digital technology use. A qualitative approach is particularly suited to investigating educational phenomena in depth, especially when practices are strongly influenced by institutional arrangements and contextual constraints (Creswell & Poth, 2018; Merriam & Tisdell, 2016). The study was informed by a socio-constructivist perspective, according to which professional practices are constructed through interactions between individuals and the social, institutional, and material environments in which they work. From this standpoint, teachers' uses of digital technologies were examined as situated practices rather than as standardized behaviors. This perspective is consistent with research emphasizing the importance of context in understanding educational digitalization (Selwyn, 2022).

A multiple-case study strategy was subsequently adopted to examine digital practices across several public secondary schools situated in different regions of Tunisia. Considering several school contexts made it possible to identify common tendencies while also taking account of variations related to local conditions, available resources, and institutional environments. The case study approach was particularly relevant for examining how teachers respond to technological limitations, institutional expectations, and pedagogical demands in their everyday professional activities (Yin, 2018; Tondeur et al., 2021). Data were collected between 2023 and 2025 in Tunisian public secondary education institutions. Three complementary sources of evidence were used: semi-structured interviews with teachers, direct classroom observations, and analysis of relevant educational documents. Combining these sources provided an opportunity to compare teachers' reported experiences with observed practices and documentary evidence. This methodological triangulation strengthened the credibility of the analysis by allowing the phenomenon to be examined from different perspectives (Denzin & Lincoln, 2018). Overall, the research design was intended to provide a contextualized account of teachers' digital practices. Rather than measuring technology use solely through predetermined indicators, the study sought to understand how digital practices are constructed, adapted, and negotiated within the concrete conditions of Tunisian public secondary schools.

2.2. Participants

The participants consisted of 32 secondary school teachers working in Tunisian public schools located in urban, semi-urban, and rural areas. A purposive sampling strategy was employed to select teachers who had direct and sustained experience with the use of digital technologies in teaching and learning

activities (Patton, 2015). The selection criteria included current employment in a public secondary school, direct experience with digital technology use in classroom or instructional activities, and willingness to participate in interviews and classroom observations. The sampling process sought to ensure diversity in terms of age, gender, teaching experience, academic discipline, geographical location, and access to technological resources. This diversity was considered important for capturing the range of professional experiences and contextual conditions that may shape teachers' digital practices in Tunisian public schools. The participants were aged between 25 and 58 years. The sample included 7 teachers aged 25–34 years (21.9%), 12 aged 35–44 years (37.5%), 9 aged 45–54 years (28.1%), and 4 aged 55–58 years (12.5%). This age distribution provided perspectives from teachers at different stages of their professional careers. In terms of gender, 18 participants were male (56.3%), and 14 were female (43.7%). Teaching experience also varied considerably: 7 teachers (21.9%) had less than five years of experience, 9 (28.1%) had between five and ten years, 10 (31.3%) had between eleven and twenty years, and 6 (18.7%) had more than twenty years of teaching experience. The combination of early-career, mid-career, and highly experienced teachers enabled the study to consider differences in professional experience and possible variations in the appropriation of digital technologies. The participants represented five broad academic disciplines: mathematics (6; 18.7%), sciences (7; 21.9%), languages (8; 25.0%), social sciences (5; 15.6%), and information technology (6; 18.7%). Including teachers from different disciplinary backgrounds was intended to avoid limiting the analysis to a single subject area and to identify common as well as discipline-specific patterns in digital practices. The geographical distribution of participants also reflected different school contexts.

Twelve teachers (37.5%) worked in urban schools, 10 (31.3%) in semi-urban schools, and 10 (31.3%) in rural schools. This distribution provided an opportunity to examine how geographical and institutional contexts may influence teachers' access to digital resources, technical support, and opportunities for technology integration. The participating schools differed substantially in terms of technological infrastructure and access to digital resources. Thirteen teachers (40.6%) reported working in schools with relatively stable digital infrastructure, whereas 19 teachers (59.4%) worked in schools characterized by more limited infrastructure. These limitations included restricted access to digital equipment, unstable or insufficient internet connectivity, and difficulties in accessing technological resources when needed for classroom activities. The inclusion of schools with contrasting technological conditions was particularly relevant to the research objective, as it made it possible to examine how teachers respond to structural constraints and how they develop context-sensitive strategies to maintain or support digital teaching practices. The diversity of the sample was therefore not intended to provide statistical representativeness of all secondary school teachers in Tunisia. Rather, it was designed to maximize variation in participants' professional and institutional experiences and to generate rich qualitative information about teachers' digital practices. In line with the qualitative orientation of the study, the sampling strategy prioritized participants who could provide detailed accounts of their experiences, perceptions, challenges, and adaptive practices (Patton, 2015; Miles et al., 2020). The combination of different age groups, levels of teaching experience, disciplines, geographical settings, and technological environments strengthened the contextual depth of the analysis.

Data collection was conducted over a six-month period, from September 2025 to February 2026. During this period, semi-structured interviews and classroom observations were conducted to document teachers' experiences, practices, challenges, and strategies related to the integration of digital technologies. The interviews provided information about teachers' perceptions of institutional support, professional development, technological constraints, and pedagogical choices, while classroom observations provided contextual evidence of how digital technologies were actually incorporated into teaching practices. The combination of these sources allowed the researchers to compare reported practices with observed classroom practices and contributed to a more comprehensive understanding of teachers' digital engagement. Participation was voluntary. Before data collection, all participants received information about the objectives and procedures of the study, the nature of their participation, the confidential treatment of the information provided, and their right to withdraw from the research at any stage without negative consequences. Informed consent was obtained from all participants before the interviews and observations were conducted. To protect participants' privacy, no personal identifiers or school names were included in the research reports. Data were treated confidentially and used exclusively for research purposes. Ethical principles relating to anonymity, informed consent, confidentiality, and data protection were respected throughout the research process (Bryman, 2016). Overall, the composition of the sample enabled the study

to examine teachers' digital practices as situated professional activities rather than as isolated individual behaviors. By bringing together teachers working under different professional, geographical, and technological conditions, the study was able to explore how structural constraints interact with teachers' professional agency, contextual knowledge, and adaptive strategies in the implementation of digital technologies in Tunisian secondary schools.

Table 1. Participants' Demographic and Professional Characteristics

Variable	Category	Number (n)	Percentage (%)
Total Participants	Secondary school teachers	32	100%
Age	25–34 years	7	21.9
	35–44 years	12	37.5
	45–54 years	9	28.1
	55–58 years	4	12.5
Gender	Male	18	56.3%
	Female	14	43.7%
Geographical Location	Urban schools	12	37.5%
	Semi-urban schools	10	31.3%
	Rural schools	10	31.3%
Teaching Experience	Less than 5 years	7	21.9%
	5–10 years	9	28.1%
	11–20 years	10	31.3%
	More than 20 years	6	18.7%
Academic Disciplines	Mathematics	6	18.7%
	Sciences	7	21.9%
	Languages	8	25.0%
	Social Sciences	5	15.6%
	Information Technology	6	18.7%
Technological Infrastructure	Stable digital infrastructure	13	40.6%
	Limited digital infrastructure	19	59.4%
Participation Conditions	Voluntary participation	32	100%
Ethical Procedures	Informed consent obtained	32	100%

2.3. Research Instruments

Data were collected through three complementary qualitative instruments: semi-structured interviews, non-participant classroom observations, and document analysis. The interview and observation protocols were designed by the researchers specifically for this study. Their development was guided by the research questions and by methodological principles established in the literature on qualitative inquiry, particularly those concerning semi-structured interviewing and classroom observation (Kvale & Brinkmann, 2015; Cohen et al., 2018). Rather than reproducing an existing instrument, the researchers adapted the content and wording of the protocols to the Tunisian educational context and to the specific issue of teachers' digital technology practices. The interview guide contained approximately 12 open-ended questions, with additional prompts used when participants needed to clarify or develop their responses. The questions were grouped around five broad areas: teachers' access to digital technologies, their ways of using digital tools for teaching, their digital skills and professional development, the support provided by schools and institutions, and the difficulties they experienced when integrating technology into their everyday practice. The questions were intentionally open in order to give teachers sufficient space to describe their own experiences and to raise issues that were not necessarily anticipated by the researchers. For example, participants were asked:

> *"Which digital tools do you usually use in your teaching, and for what purposes?"*; *"Can you describe a teaching situation in which a digital technology was particularly useful?"*; *"What kind of support do you receive when you encounter difficulties with digital technologies?"*; and *"How do you deal with technological or institutional constraints in your daily teaching practice?"*

The interviews generally lasted between 45 and 75 minutes. They were conducted either in person or online, according to the participants' availability and geographical circumstances. Before each interview, the purpose of the research was explained, and participants were informed about the confidentiality of the

data. Interviews were audio-recorded only after obtaining participants' consent and were subsequently transcribed verbatim to facilitate the qualitative analysis.

A second source of evidence was provided by non-participant classroom observations. The observation guide was likewise developed by the researchers rather than taken directly from a previously published instrument. Its construction was informed by established principles of classroom observation (Cohen et al., 2018), while its content was tailored to the objectives of the present research. The guide included approximately 20 observation indicators, distributed across five areas: the digital resources available and used during the lesson, the pedagogical role assigned to these resources, classroom interactions, classroom organization and management, and technical or contextual difficulties. During observations, particular attention was paid to what teachers actually did with digital technologies, rather than simply to whether a particular device or application was present. The researchers recorded, for example, the type of technology used, the moment at which it was introduced, its intended pedagogical function, the teacher's guidance of students during digital activities, students' participation, and the nature of teacher–student interactions. Technical problems, limited access to equipment, connectivity difficulties, or other contextual factors that influenced technology use were also noted. Typical observation criteria included: the *type and frequency of digital tools used*, the *purpose of their use*, the *teacher's role in guiding digital activities*, the *level of student participation*, the *forms of classroom interaction*, and the *technical constraints affecting the lesson*.

The observation process was conducted without direct intervention by the researchers. This non-participant position was intended to preserve the ordinary flow of classroom activities and to obtain a relatively natural account of how digital technologies were integrated into teaching. Observation data therefore provided an opportunity to compare teachers' stated practices during interviews with their practices as they occurred in actual classroom situations. Finally, document analysis was used to provide the institutional and policy background necessary for interpreting the empirical data. The documents examined included official educational guidelines, institutional documents, teacher-training materials, and policy documents addressing digital education and technological transformation in the Tunisian education system. The analysis focused particularly on the place attributed to digital technologies in educational policy, expectations concerning teachers' digital competencies, professional development provisions, and institutional conditions for technology integration. This documentary material was not considered as a separate source of findings but as contextual evidence that helped situate teachers' practices within the broader educational environment (Bowen, 2009). Using these three sources made it possible to approach the phenomenon from different perspectives. Teachers' accounts provided access to their perceptions and experiences, classroom observations made it possible to examine their practices directly, while documentary sources helped identify the institutional expectations and conditions surrounding digital technology integration. The convergence and comparison of these sources consequently supported the credibility and trustworthiness of the qualitative interpretation through methodological triangulation (Flick, 2018; Tracy, 2020).

2.4. Procedures

Data collection was organized progressively, from participant recruitment to interviews, classroom observations, and documentary collection. Before beginning the empirical work, the researchers obtained the necessary authorization to access the participating schools from the relevant educational authorities and school administrations. Once institutional access had been secured, teachers who met the selection criteria were approached and informed about the purpose of the study, the nature of their expected participation, and the procedures involved. Participation was voluntary, and teachers were given the opportunity to ask questions before agreeing to take part in the study. The researchers also emphasized that participation would have no impact on teachers' professional status or evaluation and that the information collected would be treated confidentially. Potential participants were contacted directly through the participating schools. Recruitment was guided by the inclusion criteria established for the study, particularly teachers' direct experience with the use of digital technologies in their teaching activities. Efforts were made to include teachers working in different educational and institutional contexts in order to capture a diversity of experiences and perspectives. Once teachers expressed their willingness to participate, an individual appointment was arranged with each participant. The researchers explained that the study focused on teachers' experiences and practices concerning the integration of digital technologies, with particular

attention to the conditions, institutional constraints, and contextual factors shaping their everyday use of these technologies. Teachers who agreed to participate were then contacted individually to arrange the interviews and, where applicable, the classroom observations.

The semi-structured interviews were scheduled at times that were convenient for the participants and did not interfere with their teaching responsibilities. Depending on participants' geographical location, availability, and practical circumstances, interviews were conducted either face-to-face or online. Face-to-face interviews were generally held in a quiet and sufficiently private setting within the school or another mutually agreed location. Online interviews were conducted using an appropriate videoconferencing platform. Regardless of the mode of administration, the same interview guide was used to maintain a common structure across the interviews while preserving the flexibility characteristic of semi-structured interviewing. At the beginning of each interview, the researcher briefly introduced the study and explained the purpose of the conversation. Participants were reminded that their participation was voluntary and that they could decline to answer a question or stop the interview if they wished. After obtaining consent, the interview proceeded from general questions about teachers' experiences with digital technologies toward more specific questions concerning pedagogical practices, institutional support, professional development, difficulties, and strategies for dealing with constraints. The questions were presented in a flexible order when the discussion required it, and additional prompts were used to encourage participants to clarify or elaborate on their experiences. This flexible approach allowed the researchers to follow issues raised spontaneously by participants while ensuring that the main themes of the interview protocol were addressed with all participants.

The interviews generally lasted between 45 and 75 minutes. Particular attention was paid to creating a respectful and non-judgmental interactional setting so that teachers could discuss their practices, difficulties, institutional experiences, and ways of adapting to technological constraints as freely as possible. With participants' permission, interviews were audio-recorded to avoid loss of information and to facilitate accurate transcription. The recordings were subsequently transcribed verbatim and checked against the original recordings before being prepared for qualitative analysis. During this stage, identifying information was removed or replaced with appropriate codes in order to preserve participants' anonymity. Classroom observations were organized after consultation with the participating teachers and the relevant school administrations. Observation sessions were scheduled according to the teachers' timetables, the availability of the researchers, and the practical conditions of the schools, while avoiding unnecessary disruption to normal teaching activities. When an observation was planned, the researcher confirmed the date, time, class, and lesson context with the teacher in advance. The purpose of the observation was not to evaluate the teacher's performance but to document how digital technologies were actually incorporated into ordinary teaching situations.

The observations were conducted in a non-participant manner: the researchers remained observers and did not intervene in the pedagogical activities. At the beginning of each session, the researcher positioned themselves in a way that minimized interference with classroom activities. The observation guide described in Section 2.3 was used systematically to record the types of digital technologies employed, their pedagogical purposes, teacher–student interactions, student participation, classroom organization, and any technological or infrastructural difficulties encountered during the lesson. Particular attention was given to the relationship between the technology used and the pedagogical activity, including whether digital tools were used for presenting information, explaining concepts, facilitating interaction, supporting student activities, assessing learning, or enabling students to produce content. Field notes were taken throughout each observation session. These notes included both descriptive information about what occurred in the classroom and brief analytical remarks concerning situations that appeared relevant to the research questions. Where technological problems, connectivity limitations, lack of equipment, or other contextual difficulties affected the lesson, these circumstances were recorded as part of the observation rather than interpreted in isolation. After each observation, the field notes were reviewed and organized while the details of the session were still recent, allowing the researchers to preserve contextual information that might not have been apparent from the observation grid alone.

Alongside the interviews and observations, relevant institutional, pedagogical, and policy documents were collected. These included documents relating to digital education, teacher professional development, institutional orientations, and the integration of digital technologies within the Tunisian educational system. Documents were selected according to their relevance to the research questions and their capacity to

provide information about the institutional and policy environment in which teachers' digital practices were situated. Documentary sources were examined in relation to the themes emerging from the interviews and classroom observations, rather than being treated independently from the other sources of evidence. The three sources of data were progressively compared during the research process. Teachers' accounts obtained through interviews were examined alongside their observed classroom practices and the institutional context documented through official and pedagogical materials. This process of comparison helped identify both convergences and discrepancies between reported and observed practices. For example, when teachers described a particular pedagogical use of digital technology during interviews, the observation data were considered to determine how, and under what classroom conditions, such practices were enacted. Similarly, institutional and policy documents were used to examine whether the conditions reported by teachers were consistent with the broader educational orientations and support mechanisms described in official documents. Data management was conducted continuously throughout the research process. Interview recordings, transcripts, observation notes, and documentary materials were systematically organized and assigned appropriate identifiers. The researchers maintained a clear separation between participants' identities and the qualitative data used for analysis. All collected materials were stored securely and were accessible only to the research team. This procedure facilitated the subsequent coding and comparison of the different sources while maintaining the confidentiality of participants. Finally, the researchers engaged in continuous reflexive examination of the data collection process. Emerging interpretations were discussed and compared across interviews, observations, and documentary sources rather than being based on a single type of evidence. Particular attention was paid to the researchers' own assumptions and to the possibility that the presence of an observer or the interview situation could influence participants' responses or classroom practices. This reflexive approach, combined with the systematic comparison of multiple sources, contributed to the credibility, coherence, and trustworthiness of the qualitative interpretation (Lincoln & Guba, 1985; Creswell & Creswell, 2023).

2.5. Data Analysis

The qualitative material generated through the semi-structured interviews, non-participant classroom observations, and documentary analysis was examined using a thematic content analysis approach. This approach was considered appropriate because it allowed the researchers to move from participants' detailed accounts and observed classroom practices to broader patterns of meaning while preserving the contextual specificities of teachers' experiences. The analysis was therefore not limited to counting the occurrence of particular responses or codes; rather, it sought to understand how teachers interpreted, negotiated, and adapted their use of digital technologies within the institutional and material conditions of Tunisian public secondary education (Braun & Clarke, 2022). The analysis was conducted through a series of interconnected and iterative stages. Initially, the researchers organized the qualitative corpus by source and participant and prepared the interview transcripts, classroom observation notes, and documentary materials for analysis. The interview recordings were transcribed verbatim, while observation notes were reviewed and completed immediately after the observation sessions. The documentary material was organized according to its institutional or pedagogical origin and its relevance to the research questions. This organization made it possible to maintain the contextual identity of each data source while facilitating subsequent cross-source comparison.

The first analytical stage consisted of familiarization with the data. The researchers independently read the interview transcripts and observation notes several times and examined the relevant documentary material. During these readings, they highlighted significant passages, recorded preliminary interpretations, and identified issues that appeared repeatedly across participants or settings. Particular attention was paid not only to explicit statements but also to contextual elements that could help explain why teachers adopted particular digital practices. Reflexive notes were maintained throughout this stage to document emerging ideas and questions and to avoid premature closure around an initial interpretation. The second stage involved initial coding. Two researchers were directly involved in the coding of the qualitative corpus. Each researcher independently coded meaningful segments of the interview transcripts, observation notes, and documentary material. The coding process was primarily inductive, allowing concepts to emerge from the data while remaining connected to the research objectives and conceptual orientation of the study. Initial codes addressed, among other issues, access to digital resources, technological infrastructure, digital

competencies, pedagogical uses of technology, professional development, institutional support, technical difficulties, workload, pedagogical adaptation, teacher agency, and contextual constraints (Saldaña, 2021).

The researchers deliberately coded beyond isolated words or expressions and considered the meaning of statements within their broader context. For example, a teacher's reference to a lack of equipment was not automatically interpreted only as a technological constraint; the surrounding account was examined to determine whether the reported lack of resources influenced lesson planning, pedagogical choices, student participation, or the teacher's decision to replace a digital activity with a more traditional one. This approach helped preserve the relationship between teachers' reported experiences and the practical conditions in which those experiences occurred. Following the initial independent coding, the two researchers compared their coding decisions. Particular attention was given to codes that appeared similar, overlapping, or potentially ambiguous. When differences emerged, the researchers returned to the original data segment and discussed the interpretation in relation to the surrounding text, the research questions, and the developing coding framework. The purpose of this procedure was not to eliminate interpretive differences mechanically but to establish a shared and defensible understanding of the codes. Where necessary, codes were merged, renamed, divided, or more precisely defined. Disagreements were resolved through discussion and consensus between the two researchers. To further improve coding consistency, the researchers maintained a shared coding framework containing the main codes, their definitions, and the distinctions between closely related categories. The framework was progressively refined as new data were examined. This iterative process helped ensure that the same analytical criteria were applied across different interviews and data sources while still allowing new themes to emerge when they were supported by the empirical material.

The researchers also revisited previously coded material when substantial changes were made to the coding framework, thereby limiting inconsistencies between earlier and later stages of analysis. After the initial codes had been reviewed and consolidated, related codes were grouped into broader thematic categories. The researchers examined relationships between codes and considered whether particular codes represented different dimensions of the same underlying issue. The emerging categories were then reviewed against the complete dataset. Themes were retained when they were sufficiently supported by the data and when they contributed meaningfully to answering the research questions. Themes that were too broad, repetitive, or insufficiently supported were reorganized or excluded. This process resulted in a progressively more coherent thematic structure that captured both common patterns and variations across participants and school contexts. An important part of the analysis consisted of cross-source comparison and methodological triangulation. The researchers compared teachers' statements during interviews with evidence from classroom observations and relevant institutional or policy documents. This made it possible to distinguish between what teachers reported doing and what could be observed in actual classroom situations. It also provided a means of situating individual experiences within the wider institutional and policy environment. Convergences between the sources strengthened particular interpretations, while divergences were not automatically treated as inconsistencies or errors. Instead, they were examined as potentially meaningful indications of differences between teachers' perceptions, classroom realities, and institutional expectations (Flick, 2018).

The researchers also used reflexive memoing throughout the analytical process. These memos documented analytical decisions, emerging interpretations, uncertainties, and possible researcher assumptions. Reflexivity was particularly important because qualitative interpretation necessarily involves interaction between the researchers' perspectives and the meanings expressed by participants. Regular discussions between the two researchers provided an additional opportunity to question initial interpretations and consider alternative explanations before finalizing the thematic structure. The final stage involved integrating the refined themes into an interpretive account of teachers' digital practices. Rather than presenting the themes as isolated categories, the analysis examined the relationships between structural conditions, institutional support, teachers' professional resources, pedagogical choices, and situated forms of adaptation**.** Particular attention was given to the ways in which teachers negotiated constraints and developed context-dependent strategies for incorporating digital technologies into their teaching. Overall, the combination of independent coding by two researchers, systematic comparison of coding decisions, consensus-based resolution of discrepancies, iterative refinement of the coding framework, reflexive memoing, and triangulation across interviews, observations, and documents was used to enhance the consistency and credibility of the analysis. These procedures strengthened the transparency of the analytical

process while recognizing the interpretive nature of qualitative research. The resulting analysis provides a nuanced account of the relationship between structural inequalities, institutional conditions, and teachers' situated strategies for digital technology appropriation in Tunisian public secondary education (Braun & Clarke, 2022; Saldaña, 2021; Flick, 2018; Selwyn, 2022).

3. RESULTS

3.1. Structural and Technological Constraints Affecting Digital Practices

The findings indicate that teachers' digital practices in Tunisian public secondary schools are strongly influenced by a combination of structural, technological, and institutional constraints. Across the interviews, participants consistently identified inadequate digital infrastructure, unstable Internet connectivity, insufficient or outdated equipment, limited access to digital platforms, disparities between schools, insufficient professional development, and heavy administrative and curricular demands as major barriers to the effective integration of digital technologies. These constraints did not simply affect the frequency with which teachers used digital tools; they also influenced the types of activities they were able to design, the degree of pedagogical innovation they could undertake, and their confidence in relying on technology during classroom instruction.

3.1.1. Internet Connectivity and Technological Reliability

Internet connectivity emerged as one of the most frequently reported difficulties. Participants explained that unstable or slow Internet connections could interrupt planned activities, reduce lesson continuity, and force teachers to abandon digital resources at the last minute. The problem was particularly significant when lessons depended on online videos, educational platforms, interactive resources, or real-time access to information. As one teacher explained:

> "*Sometimes I prepare the whole lesson using videos and online resources, but when I arrive in the classroom, the Internet does not work. I have no choice but to continue the lesson without the digital activity.*" (Teacher 7)

This statement illustrates the gap that may exist between teachers' pedagogical intentions and the material conditions in which those intentions have to be implemented. The teacher may have carefully planned a technology-supported lesson, yet the instability of the technological environment can transform the planned activity into a conventional lesson. Digital integration therefore appears not simply as a matter of teachers' willingness to use technology, but as a practice dependent on the reliability of the infrastructure available at the moment of teaching. Another participant emphasized the unpredictable nature of this situation:

> "*The problem is not that we have no technology at all. The problem is that we cannot always rely on it. The connection may work today and fail tomorrow, and this makes it difficult to plan a lesson around digital resources.*" (Teacher 12)

This account highlights an important dimension of technological constraint: unpredictability. When teachers cannot anticipate whether a technological resource will function, they may become reluctant to incorporate it into activities that are central to the lesson. Consequently, technology may be used as an additional or optional resource rather than as an integral component of the pedagogical design. The findings further suggest that technological interruptions have consequences beyond the immediate technical problem. Participants described feelings of frustration and reduced confidence when digital activities failed in front of students. In such situations, teachers had to improvise, modify the planned sequence, or return to more familiar teaching methods. Thus, technological unreliability may reinforce a preference for traditional practices because these practices are perceived as more predictable under constrained conditions.

3.1.2. Unequal Access to Technological Equipment

Participants also described significant disparities in the availability, quality, and accessibility of technological equipment across schools. While some urban institutions benefited from relatively functional digital environments, teachers working in less well-resourced schools reported difficulties in accessing computers, projectors, computer laboratories, and other technological resources. In some cases, equipment

was formally available but could not be used regularly because of maintenance problems or insufficient numbers of functional devices. One participant noted:

> "*We have a computer room, but having a room does not mean that we can use it regularly. Some computers do not work, and sometimes there are not enough computers for the students.*" (Teacher 4)

This account demonstrates that the existence of technological infrastructure does not necessarily imply effective technological accessibility. A computer laboratory may appear in the school's inventory, but its pedagogical value is considerably reduced if equipment is obsolete, unavailable, poorly maintained, or insufficient for the number of students. The findings also reveal a geographical and institutional dimension to digital inequality. Teachers working in under-resourced schools frequently described a stronger sense of professional isolation and limited institutional support. Such disparities contribute to differentiated digital practices across schools: teachers with access to functional infrastructure can experiment with a broader range of digital activities, whereas those working in technologically constrained environments are more likely to restrict their use of digital tools to simple, low-risk applications. This situation suggests that digital transformation within Tunisian public secondary education is not experienced uniformly. Rather, teachers' opportunities to innovate are partly conditioned by the institutional environment in which they work. Consequently, the same national digital education policy may produce different practical outcomes depending on the material and technological resources available at school level.

3.1.3. Limited and Insufficiently Contextualized Professional Development

Another important constraint concerned teachers' access to continuous professional development. Participants reported that training opportunities in educational technologies were limited and, in some cases, insufficiently connected to everyday classroom realities. Teachers did not necessarily reject professional development; rather, they emphasized the need for training that was practical, sustained, and adapted to the specific conditions of Tunisian classrooms. One teacher stated:

> "*We need practical training. Sometimes the training explains what a digital tool is, but it does not show us how to use it with thirty or forty students in a real classroom.*" (Teacher 15)

This statement points to a distinction between knowing about a digital tool and knowing how to integrate it pedagogically. Teachers may acquire technical knowledge without necessarily developing the pedagogical competence required to select an appropriate tool, adapt it to curricular objectives, manage students' use of technology, and evaluate the learning outcomes produced by the activity. The interviews also indicate that teachers frequently compensated for limited formal training through self-directed learning:

> "*Most of what I know about digital tools, I learned by myself. I search on the Internet, I watch tutorials, and I ask colleagues when I have a problem.*" (Teacher 9)

Self-training thus emerged as an important mechanism through which teachers attempted to overcome institutional limitations. However, reliance on individual learning also produces differences in teachers' digital competencies because opportunities for experimentation, access to resources, and levels of individual motivation are not necessarily equally distributed. Moreover, the findings suggest that professional development should not be considered independently of teachers' working conditions. Training that is not accompanied by sufficient time, equipment, technical assistance, and institutional encouragement may have limited effects on long-term classroom practices. Teachers therefore appear to need not only training opportunities but also a supportive professional environment in which newly acquired competencies can be tested, refined, and shared with colleagues.

3.1.4. Administrative Workload and Curricular Pressure

Administrative workload and rigid curricular expectations constituted an additional layer of constraint. Participants explained that meaningful digital integration required substantial preparation time. Teachers had to search for appropriate resources, evaluate their quality, adapt them to curricular objectives, prepare technological materials, test links or applications, and anticipate possible technical problems. As one participant remarked:

> "*Using digital technology takes time. You have to search for resources, prepare the activity, check whether the links work, and think about how the students will use the tool. With the workload we already have, this is not always easy.*" (Teacher 18)

This account highlights the often-overlooked temporal dimension of digital integration. Technology may potentially facilitate teaching, but its effective pedagogical use can initially require additional preparation. When teachers are already subject to heavy administrative responsibilities and curricular demands, the time required to design digital activities can become a significant barrier. The findings suggest that this pressure may encourage teachers to select simple and easily accessible digital resources rather than more complex interactive or collaborative activities. In this sense, structural constraints may influence not only whether teachers use technology but also how they use it. Digital technologies may therefore be incorporated primarily for presentation, information retrieval, communication, or access to multimedia resources rather than for deeper pedagogical transformation.

3.1.5. Institutional Support and Professional Isolation

Beyond material resources and training, participants also emphasized the importance of sustained institutional support. Teachers' accounts suggest that digital transformation requires more than the provision of equipment. It also depends on school-level policies, technical assistance, opportunities for collaboration, and recognition of teachers' efforts to innovate. In under-resourced contexts, the absence of such support may generate feelings of professional isolation. Teachers may feel that responsibility for digital integration has been transferred to them individually, requiring them to purchase equipment, develop their own competencies, solve technical problems, and adapt available resources without sufficient institutional assistance. This situation creates a paradox. Teachers are increasingly expected to integrate digital technologies into their teaching, while the organizational and material conditions required to support this integration may remain insufficient. As a result, digital innovation may become dependent on individual teachers' motivation, personal resources, and willingness to invest additional time and effort.

The findings therefore point to a broader institutional issue: digital transformation cannot be sustained through individual teacher initiative alone. Where institutional support is weak, innovative practices may remain isolated, irregular, and vulnerable to changes in individual motivation or working conditions.

3.1.6. Consequences for Pedagogical Integration

Taken together, the findings demonstrate that structural and technological constraints have direct consequences for teachers' pedagogical practices. First, unreliable infrastructure limits the predictability of technology-supported lessons. Second, unequal access to equipment produces disparities in teachers' opportunities to experiment and innovate. Third, insufficiently contextualized professional development limits teachers' capacity to transform technological tools into pedagogically meaningful activities. Finally, administrative workload and curricular pressure reduce the time available for designing, implementing, and evaluating innovative digital practices. Importantly, these constraints do not imply that teachers reject digital technologies. Rather, they reveal that teachers frequently have to negotiate between their pedagogical intentions and the realities of their institutional environments. As a result, technology tends to be integrated in pragmatic and selective ways, with teachers prioritizing tools that are accessible, familiar, and relatively reliable. Overall, the findings show that teachers' digital practices are shaped by the interaction of technological limitations, institutional conditions, professional development opportunities, and workload pressures. The data point to a tension between the policy-level aspiration toward digital transformation and the everyday realities experienced by teachers in public secondary schools. Under these conditions, digital integration often remains pragmatic and adaptive rather than fully transformative. At the same time, the constraints identified in this section help explain why teachers subsequently develop personal and collective strategies to compensate for institutional limitations, as discussed in Section 3.2.

3.2. Teachers' Adaptive Strategies and Professional Agency

Despite the structural, technological, and institutional constraints described above, the findings reveal that teachers did not remain passive in the face of these difficulties. Instead, they developed a range of adaptive strategies to maintain, extend, and sometimes reinvent their use of digital technologies. These strategies included the mobilization of personal technological resources, informal collaboration with colleagues, the selective use of accessible digital tools, the adaptation of activities to students' unequal technological access, and continuous experimentation. Taken together, these practices provide evidence of significant professional agency, understood here as teachers' capacity to respond creatively to contextual constraints and to negotiate available resources in order to pursue their pedagogical objectives (Priestley et al., 2015). Rather than implementing digital technologies according to a fixed institutional model, participants appeared to construct situated forms of digital practice. Their accounts suggest that digital integration was often a process of adjustment in which teachers evaluated what was available, anticipated possible difficulties, and modified their practices according to the characteristics of their schools and students. In this respect, teachers acted not merely as users of technological resources but as active agents who negotiated the conditions under which these resources could be meaningfully incorporated into teaching.

3.2.1. Mobilizing Personal Technological Resources

One of the most recurrent strategies identified in the interviews was teachers' reliance on personal technological equipment. Participants frequently reported using their own smartphones, laptops, tablets, and personal Internet subscriptions to compensate for limitations in school infrastructure. These personal resources enabled teachers to prepare lessons, access online materials, display multimedia resources, communicate with students, and continue using digital technologies despite the shortcomings of institutional equipment. One participant explained:

> "*I often use my own laptop because I cannot depend on the school equipment. I also use my phone and my own Internet connection when I need to show something to the students.*" (Teacher 3)

Another teacher described this personal investment as almost unavoidable:

> "*If I waited for the school to provide everything I need, I would use technology very rarely. I use my personal equipment because I want to keep trying new things with my students.*" (Teacher 11)

These accounts reveal an important form of professional agency. Faced with limited institutional provision, teachers did not necessarily abandon digital practices; instead, they mobilized their own material resources to preserve pedagogical continuity. Personal technological equipment consequently functioned as a form of compensation for institutional deficiencies. This phenomenon also illustrates a broader tension within teachers' digital practices. On the one hand, personal investment demonstrates commitment, initiative, and professional resilience. On the other hand, it suggests that part of the responsibility for implementing digital education may be transferred from educational institutions to individual teachers. As Selwyn (2022) argues, digital inequalities cannot be understood solely in terms of access to technologies; they are also related to the social and institutional conditions under which technologies are used. In the present findings, teachers' personal investments partly concealed institutional deficiencies while simultaneously enabling digital practices to continue. The interviews further suggest that the use of personal devices was not restricted to lesson preparation. Teachers also used their smartphones and laptops during classroom activities, particularly when school equipment was unavailable or unreliable. One participant stated:

> "*Sometimes I prepare everything at home on my laptop and then use my phone in the classroom because there is no guarantee that the school computer will work.*" (Teacher 5)

Such practices illustrate the highly pragmatic character of teachers' digital appropriation. Rather than waiting for ideal technological conditions, teachers combined whatever resources were immediately available in order to achieve their pedagogical objectives.

3.2.2. Informal Peer Collaboration and Collective Problem-Solving

Peer collaboration emerged as another important adaptive strategy. Participants described informal exchanges with colleagues through which they shared digital resources, applications, tutorials, technical solutions, and pedagogical ideas. These interactions constituted an important source of professional learning, particularly in contexts where formal training was perceived as insufficient. As one teacher explained:

> "*When I discover a useful application, I show it to my colleagues. They also share videos or activities with me. We learn from each other because formal training is not enough.*" (Teacher 6)

Another participant emphasized the practical value of this informal support:

> "*Sometimes a colleague solves a technical problem in five minutes because he has already experienced it. This kind of help is very important for us.*" (Teacher 14)

These accounts indicate that teachers' digital competencies were developed not only through formal professional development but also through everyday interactions with colleagues. Informal peer networks provided immediate and context-sensitive solutions to problems that teachers encountered in their classrooms. Unlike formal training, which may occur outside the immediate teaching context, peer assistance was directly connected to teachers' concrete needs. This finding is consistent with the importance attributed to collaborative professional learning in the development of teachers' digital practices (Trust et al., 2016). In the present study, collaboration appeared to operate at several levels. Teachers shared technological knowledge, recommended useful applications, exchanged teaching materials, and provided immediate technical assistance. Collaboration therefore served both a pedagogical and a technical function. The findings also suggest that such informal collaboration contributed to reducing professional isolation. Teachers working in technologically constrained environments could rely on colleagues to overcome technical problems and to discover alternative ways of using digital resources. One participant explained:

> "*When I do not know how to use a tool, I usually ask another teacher. Sometimes we sit together and try it until we find a solution. We learn much more this way than by simply reading instructions.*" (Teacher 10)

This type of collaborative experimentation reflects the collective dimension of teachers' professional agency. Agency was therefore not exclusively an individual characteristic; it was also constructed through relationships with colleagues and through participation in informal professional networks.

3.2.3. Selective Appropriation Of Accessible Digital Tools

Teachers also reported developing pragmatic approaches to the selection of digital technologies. Rather than relying exclusively on sophisticated educational platforms, participants frequently used accessible and familiar tools such as online videos, messaging applications, search engines, social media, and open educational resources. These tools were valued because they were relatively easy to access and because both teachers and students were already familiar with them. One participant stated:

> "*I do not always use sophisticated platforms. Sometimes a simple video or a messaging application is more useful because both the teacher and the students already know how to use it.*" (Teacher 2)

This finding suggests that teachers' digital choices were guided not only by the pedagogical potential of a technology but also by considerations of accessibility, familiarity, reliability, and students' technological competencies. In other words, teachers appeared to privilege technologies that could be realistically integrated into their everyday teaching conditions. Another participant explained:

> "*I choose tools that do not require too much technical preparation. If the students already know how to use the application, I can concentrate more on the learning objective.*" (Teacher 13)

This selective appropriation illustrates a form of situated digital literacy. Teachers did not simply adopt technologies because they were considered innovative; rather, they evaluated their practical usefulness within particular classroom contexts. Such practices support the view that digital integration is not a linear process of technological adoption but a process of contextual appropriation (Bozkurt & Sharma, 2020). The use of accessible digital tools also allowed teachers to maintain pedagogical continuity when official platforms or school infrastructure were inadequate. Online videos, messaging applications, and freely

available educational resources could be incorporated with relatively limited technical requirements. Consequently, these tools became practical alternatives in resource-constrained environments.

3.2.4. Adapting Practices to Students' Unequal Access

Another important dimension of teachers' adaptive strategies concerned students' unequal access to digital technologies outside school. Participants recognized that students did not necessarily possess the same devices, Internet connections, digital competencies, or opportunities for home-based digital learning. Teachers therefore attempted to modify activities to avoid excluding students with limited access. One teacher explained:

> "I *cannot give the same online task to everyone without thinking about their situation. Some students have Internet at home, but others do not. So I try to provide alternatives.*" (Teacher 16)

This statement illustrates teachers' awareness of the social dimension of digital inequality. Rather than assuming that all students could participate equally in technology-based activities, teachers attempted to take differences in students' circumstances into account. Another participant stated:

> "*Some students have a smartphone and Internet access, while others share a phone with their family or have very limited Internet. I have to think about this when I prepare an online activity.*" (Teacher 4)

Such adaptations reveal that teachers' digital practices were shaped by a continuous negotiation between technological possibilities and students' actual living conditions. Teachers sometimes simplified activities, provided alternative materials, or relied on communication tools that were more widely accessible. This situated approach is particularly significant because it demonstrates that teachers' agency was exercised not only in relation to institutional constraints but also in response to social inequalities among students. The teacher's role therefore involved mediating between digital opportunities and the unequal conditions under which students could access those opportunities. These practices are consistent with the broader concern expressed by UNESCO (2023) regarding equitable access to digital education. The findings suggest that teachers attempted to compensate at the classroom level for inequalities that could not always be resolved institutionally.

3.2.5. Experimentation, Improvisation, and Situated Innovation

The interviews further revealed that experimentation and improvisation constituted important elements of teachers' digital practices. Participants frequently described learning through trial and error, gradually modifying activities according to their experiences with students. Digital competence was therefore represented not as a fixed body of knowledge acquired once through training but as an evolving professional capacity developed through practice. As one participant observed:

> "*You learn by trying. Sometimes the activity works very well, sometimes it does not, and then you change it the next time. There is a lot of experimentation.*" (Teacher 20)

This statement highlights the iterative nature of teachers' digital appropriation. Teachers experimented with tools, observed students' responses, identified difficulties, and modified subsequent activities. Such processes indicate that innovation was often incremental rather than radical. Another participant explained:

> "*At first, I was afraid that the students would have technical problems, so I started with very simple activities. When I saw that they could manage them, I gradually introduced more complex tasks.*" (Teacher 17)

This gradual approach demonstrates how teachers constructed confidence through experience. Rather than adopting complex technological practices immediately, they developed their digital practices progressively in response to classroom feedback. The findings also suggest that improvisation was sometimes necessary because of unpredictable technological conditions. When Internet connections failed, equipment malfunctioned, or students experienced access difficulties, teachers had to modify activities in real time. One participant noted:

"*You always need a Plan B. If the Internet does not work, I cannot stop the lesson. I have to find another way to explain the same idea.*" (Teacher 8)

This capacity to develop alternatives illustrates the adaptive dimension of professional agency. Teachers' digital competence therefore involved not only the ability to operate technological tools but also the ability to anticipate problems, respond to unexpected situations, and maintain pedagogical objectives under changing conditions.

3.2.6. From Individual Adaptation to Situated Professional Agency

Taken together, the findings reveal a strong form of situated professional agency. Teachers responded to structural constraints through a combination of individual initiative and collective action. They invested personal resources, relied on colleagues, selected accessible technologies, adapted activities to students' circumstances, and learned through experimentation. This agency should not, however, be interpreted as evidence that structural constraints are insignificant. On the contrary, teachers' adaptive strategies often emerged precisely because institutional conditions were insufficient. Personal equipment, peer support, and self-training functioned as compensatory mechanisms that allowed teachers to continue using digital technologies despite infrastructural and organizational limitations. The findings therefore point to a dynamic relationship between constraint and agency. Constraints did not eliminate teachers' capacity to act; instead, they shaped the forms that this agency took. Teachers' agency was expressed through adaptation, negotiation, improvisation, and contextualized decision-making rather than through the straightforward implementation of institutional digital policies. This interpretation is consistent with the conception of teacher agency as situated within structural and cultural conditions (Priestley et al., 2015).

Moreover, the results indicate that teachers' adaptive strategies generated localized forms of digital innovation. Rather than reproducing externally prescribed technological models, teachers developed practices that responded to the concrete realities of their classrooms. Such situated innovation reflects teachers' capacity to transform constraints into opportunities for experimentation and problem-solving (Day & Gu, 2018). Overall, the findings demonstrate that Tunisian secondary school teachers occupy an active position in the process of digital transformation. They are not merely passive recipients of technological reforms or institutional prescriptions. They actively negotiate available resources, construct informal professional networks, adapt digital activities to unequal student conditions, and develop their competencies through continuous experimentation. Nevertheless, the reliance on individual agency also reveals the limits of a transformation that depends heavily on teachers' personal resources and motivation. Sustainable digital integration therefore requires a shift from predominantly individual forms of adaptation toward stronger institutional support, collaborative professional cultures, equitable technological provision, and context-sensitive professional development. In this sense, teachers' adaptive strategies should be understood simultaneously as evidence of professional resilience and as an indicator of structural gaps within the digital transformation of Tunisian public secondary education. Their capacity to innovate under constrained conditions represents an important resource for educational change, but it cannot substitute indefinitely for reliable infrastructure, institutional support, and sustained professional development.

3.3. Emerging Innovations and Transformations in Teaching Practices

The findings reveal the emergence of several transformations in teachers' pedagogical practices associated with the increasing use of digital technologies. Although the process of digital integration remained uneven across schools and teachers, participants described a gradual diversification of teaching practices and learning opportunities. The most frequently reported changes concerned student motivation and participation, the diversification of pedagogical resources and methods, the development of student autonomy, the transformation of teacher–student communication, and the emergence of more flexible forms of learning. These developments nevertheless remained strongly dependent on teachers' individual initiative and on the material and institutional conditions available in their schools. The findings therefore suggest that digital technologies are beginning to reshape aspects of classroom practice, although they have not resulted in a complete transformation of the dominant pedagogical model. Rather, the data point to an incremental process in which teachers combine traditional instructional approaches with emerging digital

practices. This coexistence between established and innovative practices is particularly important for understanding digital transformation in the Tunisian public secondary school context.

3.3.1. Digital Technologies and Student Motivation and Engagement

One of the most recurrent positive effects identified in the interviews concerned students' motivation and classroom engagement. Participants reported that multimedia resources, educational videos, animations, images, and interactive presentations could attract students' attention and make lessons more dynamic. Digital resources were particularly valued when they enabled teachers to represent phenomena or concepts that were difficult to illustrate through conventional explanations alone. As one participant explained:

> "*When I use a video or an animation, I notice that students become more attentive. They ask more questions because they can see the phenomenon instead of only hearing me explain it.*" (Teacher 5)

Another teacher similarly observed:

> "*Digital resources make the lesson more attractive. Even students who are usually quiet sometimes participate when we use a video or an interactive activity.*" (Teacher 13)

These accounts suggest that digital technologies can alter the interactional dynamics of the classroom. Rather than receiving information exclusively through oral explanation or printed materials, students may encounter content through multiple modalities, including images, videos, animations, and interactive resources. Such multimodal access can make learning content more visible, concrete, and accessible. This finding is consistent with the broader literature emphasizing the potential of digital technologies to increase learner engagement and facilitate more flexible learning environments (Fullan et al., 2020). However, the interview data suggest that the effect of technology on motivation is not automatic. Teachers' pedagogical choices remain central. A video, animation, or digital resource becomes pedagogically meaningful when it is integrated into a purposeful learning activity rather than simply added to the lesson as an attractive technological element. One teacher emphasized this distinction:

> "*The students like videos, but I cannot use a video just because it is interesting. I have to choose something that helps them understand the lesson and then ask questions about it.*" (Teacher 6)

This account indicates that teachers increasingly recognize the need to move from simple technological exposure toward pedagogically structured use. Digital resources therefore appear to function most effectively when they are connected to learning objectives, questioning, discussion, and student participation. The findings also indicate that digital resources may facilitate the participation of students who are less active in conventional classroom interactions. Teachers reported that some students who rarely volunteered answers became more willing to participate when digital materials were introduced. This suggests that technology may provide alternative entry points into classroom interaction and potentially contribute to more inclusive forms of participation.

3.3.2. Diversification of Pedagogical Methods

A second major finding concerns the diversification of teaching methods. Participants described moving, at least in some situations, beyond predominantly transmissive forms of teaching toward collaborative activities, online research, project work, student presentations, and other participatory approaches. Digital technologies were perceived as facilitating these practices by providing students with rapid access to information and enabling them to produce and share digital content. One teacher stated:

> "*Before, I mainly explained the lesson and the students listened. Now, I sometimes ask them to search for information, compare resources, and present what they have found. Technology makes this type of activity easier.*" (Teacher 8)

This account points to a gradual reconfiguration of classroom roles. The teacher is no longer necessarily the sole provider of information, while students may become more actively involved in searching, selecting, organizing, and presenting knowledge. Digital technologies therefore create

opportunities for a shift from purely transmissive practices toward more participatory forms of learning. Another participant emphasized the role of technology in promoting student autonomy:

> "*Students can search for information themselves. My role becomes more about guiding them and helping them evaluate what they find rather than simply giving them all the information.*" (Teacher 17)

This transformation is particularly significant because access to information does not automatically constitute learning. The teacher increasingly assumes a mediating role by helping students identify relevant information, evaluate sources, compare different perspectives, and transform information into meaningful knowledge. In this sense, digital integration may modify not only the tools used in teaching but also the distribution of pedagogical responsibilities between teachers and students. The findings are consistent with Redecker's (2020) emphasis on the potential of digital technologies to support more active, collaborative, and learner-centred pedagogies. However, the results also indicate that this transition remains partial. Traditional practices continue to coexist with digital approaches, reflecting the uneven nature of pedagogical transformation. One participant captured this coexistence:

> "*I still explain part of the lesson in the traditional way because sometimes it is faster, but I try to use digital activities when they can really add something to the learning.*" (Teacher 9)

This statement suggests that teachers do not necessarily perceive traditional and digital approaches as mutually exclusive. Instead, they select between them according to the learning objective, available resources, classroom time, and technological conditions.

3.3.3. Development of Student Autonomy and Information Literacy

The use of digital technologies also appeared to encourage greater student autonomy. Participants described activities in which students searched for information, explored online resources, prepared presentations, and completed tasks independently or collaboratively. The development of autonomy, however, was accompanied by new pedagogical challenges. Teachers increasingly needed to help students distinguish between reliable and unreliable information. One participant explained:

> "*Students can find almost anything online, but the problem is that they do not always know whether the information is correct. I have to teach them how to check the source.*" (Teacher 17)

This observation reveals an important transformation in the teacher's role. The increasing availability of information may reduce the teacher's exclusive position as a source of knowledge, while simultaneously increasing the importance of the teacher as a guide, mediator, and evaluator of information. Digital technologies therefore appeared to contribute to the development of forms of information literacy alongside subject-specific learning. Students were encouraged not only to access information but also, at least in some cases, to compare sources and evaluate their relevance. This finding complements the broader perspective of digital education, in which technological competence involves more than operational knowledge of digital tools. It also involves the capacity to navigate, interpret, evaluate, and use digital information appropriately. In this respect, the classroom use of digital technologies may contribute to broader educational objectives associated with autonomy and critical engagement with information.

3.3.4. Transformation of Teacher–Student Communication

Another important transformation concerned communication between teachers and students. Participants reported increasingly using messaging applications and digital communication platforms to share documents, provide instructions, answer questions, send reminders, and maintain contact beyond formal classroom hours. As one teacher explained:

> "*The communication does not stop when the lesson finishes. Through the messaging group, I can send a document, answer a question, or remind students about an activity.*" (Teacher 10)

Digital communication therefore extended the temporal and spatial boundaries of classroom interaction. Learning-related communication could continue after the formal lesson and, in some cases, provide students with additional opportunities to seek clarification or access resources. Another participant noted:

"*Sometimes a student sends me a question in the evening because he did not understand something in the lesson. I can answer and send an additional document or video.*" (Teacher 14)

These practices suggest the emergence of a more continuous form of pedagogical communication. The boundary between classroom-based and out-of-class learning becomes less rigid, particularly when messaging applications are used as supplementary communication channels. This finding is consistent with the literature emphasizing the role of digital communication in extending learning beyond traditional classroom boundaries (Bozkurt & Sharma, 2020). At the same time, it raises questions concerning teachers' workload and the boundaries of their professional responsibilities. Although digital communication may improve accessibility and feedback, it may also increase expectations regarding teachers' availability outside formal working hours. One teacher expressed this ambivalence:

"*It is useful to communicate with students through the group, but sometimes they send messages at any time. You need to find a balance between helping them and protecting your personal time.*" (Teacher 10)

Thus, the transformation of communication practices should be understood as both an opportunity and a potential source of additional professional pressure.

3.3.5. The COVID-19 Pandemic as a Catalyst for Digital Appropriation

The COVID-19 pandemic emerged in participants' accounts as an important catalyst for the appropriation of digital technologies. Several teachers explained that the interruption of face-to-face schooling forced them to use digital communication and online teaching tools that they had previously used only occasionally. One teacher recalled:

"*During COVID-19, we had no choice. We had to learn how to communicate with students online and how to send activities digitally. It was difficult at first, but it changed the way I use technology.*" (Teacher 1)

Another participant similarly noted:

"*The pandemic accelerated everything. Before COVID, I used some digital resources, but after that experience I became much more comfortable with online communication and digital materials.*" (Teacher 19)

These accounts suggest that the pandemic functioned as a major accelerator of digital appropriation. Teachers who had previously had limited experience with digital technologies were suddenly required to develop new practices under highly constrained circumstances. The experience was not uniformly positive. Participants also described difficulties related to unfamiliar platforms, inadequate infrastructure, limited student access, and the absence of prior preparation. Nevertheless, the crisis appears to have contributed to a longer-term increase in teachers' familiarity with digital communication and educational resources. This finding is consistent with Dhawan's (2020) analysis of the rapid transition to online education during the pandemic. However, the present findings further suggest that the experience did not simply introduce teachers to new technologies; it also altered their perceptions of what was pedagogically possible. One participant explained:

"*Before COVID, I thought that some activities could only be done in the classroom. After the pandemic, I realized that I could use digital resources to continue part of the learning outside school.*" (Teacher 1)

Thus, the pandemic appears to have had a lasting effect on teachers' digital repertoires, even though the extent to which these new practices were subsequently institutionalized remained uneven.

3.3.6. Emerging forms of collaborative and flexible learning

The findings also reveal the emergence of more flexible forms of learning. Digital technologies enabled teachers to provide resources that students could consult at different times and, in some cases, at their own pace. Educational videos, digital documents, online exercises, and messaging groups provided additional learning opportunities beyond scheduled classroom sessions. Such practices were particularly relevant when students needed additional explanations or opportunities to review previously taught content. One participant stated:

"*If a student does not understand during the lesson, I can send a video or a document that he can review later. This gives students another opportunity to learn.*" (Teacher 11)

The possibility of revisiting resources may support differentiated learning by allowing students to engage with content beyond the limited time available in the classroom. However, participants also recognized that this flexibility depends on students' access to devices and Internet connectivity. Consequently, digital flexibility does not necessarily eliminate educational inequalities. As UNESCO (2023) and OECD (2023) emphasize, unequal access to digital resources can reproduce or even intensify existing inequalities. The present findings similarly indicate that the pedagogical benefits of flexible digital learning are conditioned by students' material circumstances.

3.3.7. Fragility and Unevenness of Digital Innovation

Despite these emerging transformations, the findings indicate that digital innovation remains fragile and uneven. Teachers repeatedly emphasized that innovative practices are difficult to sustain in the absence of reliable infrastructure, continuous training, institutional support, and sufficient preparation time. One participant summarized this tension as follows:

"*We can innovate when we have the motivation, but motivation alone is not enough. We also need reliable equipment, good Internet, time, and training.*" (Teacher 12)

Another teacher highlighted the dependence of innovation on individual initiative:

"*A lot depends on the teacher. If the teacher is motivated, he or she will find solutions, but we cannot build a digital education system only on individual efforts.*" (Teacher 7)

These statements are particularly significant because they reveal the limits of an innovation model based primarily on individual teacher agency. Teachers may develop creative practices, but such practices remain vulnerable when they depend on personal resources, individual motivation, or informal support networks. This finding reinforces the results presented in Sections 3.1 and 3.2. The same teachers who demonstrated considerable professional agency also emphasized the structural conditions that constrained the sustainability of their innovations. Digital transformation therefore emerges as a dynamic tension between individual agency and institutional capacity. From the perspective of teacher agency, these findings are consistent with Priestley et al. (2015), who emphasize that professional agency is shaped by the interaction between individual capacities and contextual conditions. In the present study, teachers' capacity to innovate was evident, but the possibilities for sustaining innovation were strongly conditioned by infrastructure, workload, institutional support, and access to professional learning. The findings also resonate with Day and Gu's (2018) emphasis on teachers' resilience and capacity to sustain professional practice under challenging conditions. Participants' experimentation, improvisation, and adaptation can be understood as forms of professional resilience. However, resilience should not be interpreted as a substitute for institutional responsibility. The repeated need for teachers to compensate for structural deficiencies may itself indicate weaknesses in the educational system's support for digital transformation.

3.3.8. From Technological Adoption to Pedagogical Transformation

Taken together, the findings suggest that the integration of digital technologies is contributing to gradual changes in teachers' pedagogical practices, but that these changes do not yet constitute a uniform or comprehensive transformation of teaching. The data reveal a continuum extending from relatively conventional uses of technology, such as presenting videos or documents, to more transformative practices involving student research, collaboration, autonomy, communication, and project-based learning. This distinction is important because the presence of digital technology in a classroom should not automatically be interpreted as pedagogical innovation. A digital tool can reproduce a traditional teacher-centred approach if it is used simply to transmit information. Conversely, technology may support more transformative practices when it enables students to investigate, collaborate, create, communicate, and take greater responsibility for their learning. The findings therefore suggest that the pedagogical value of digital technologies depends less on the technologies themselves than on how teachers appropriate and integrate them into instructional processes. This interpretation is consistent with Fullan et al. (2020) and Redecker

(2020), who emphasize the importance of pedagogical transformation alongside technological adoption. The results also demonstrate that teachers' digital practices are highly situated. Participants did not simply reproduce externally prescribed models of digital education. Instead, they adapted technologies to their students, available infrastructure, curricular requirements, and personal competencies. This situated appropriation contributes to the emergence of localized forms of innovation. At the same time, the findings reveal that such innovation remains unequal between teachers and schools. Some participants were able to experiment with collaborative and interactive approaches, whereas others remained constrained by technological and organizational limitations. This unevenness means that digital transformation cannot be understood as a uniform process occurring across the Tunisian public secondary education system.

3.3.9. Overall Interpretation of Emerging Transformations

The results reveal a persistent tension between structural constraints and teachers' capacity for situated innovation. On the one hand, inadequate infrastructure, unstable connectivity, limited professional development, workload, and unequal student access constrain the development of digital pedagogies. On the other hand, teachers demonstrate considerable professional agency by adapting technologies to their circumstances, experimenting with new practices, collaborating with colleagues, and developing alternative forms of communication and learning. The interview data consequently suggest that digital technologies have begun to influence the organization of teaching and learning in Tunisian public secondary schools. Their effects are visible in increased student engagement, greater access to multimedia resources, diversification of pedagogical methods, expanded teacher–student communication, and emerging forms of learner autonomy. However, these transformations remain partial, context-dependent, and unevenly distributed. The findings therefore suggest that digital transformation should not be reduced to the provision of technological equipment. Meaningful and sustainable digital integration requires reliable infrastructure, continuous and context-sensitive professional development, institutional support, sufficient preparation time, equitable student access, and collaborative professional cultures (OECD, 2023; UNESCO, 2023). Without these conditions, innovative practices risk remaining dependent on individual motivation and personal investment.

In this regard, the teachers' accounts point toward a broader understanding of digital transformation as simultaneously technological, pedagogical, organizational, and professional. Technology can create new possibilities for interaction and learning, but these possibilities become educationally meaningful only when teachers are supported in transforming technological affordances into appropriate pedagogical practices. The findings thus position Tunisian teachers not as passive recipients of technological reforms but as active participants in the construction of locally grounded forms of digital innovation. Ultimately, the emerging transformations identified in this study should be interpreted as signs of a gradual and situated digital transition rather than a complete pedagogical revolution. Teachers are progressively experimenting with new ways of engaging students, organizing learning, communicating beyond the classroom, and supporting learner autonomy. Nevertheless, the sustainability and scalability of these innovations remain dependent on the extent to which educational institutions can move beyond reliance on individual teacher resilience and establish the structural, professional, and organizational conditions necessary for long-term digital transformation. These developments also indicate that digital transformation is progressively reshaping teachers' professional identities and roles. Rather than simply adopting digital tools, teachers are becoming designers of learning experiences that combine technological resources with contextual knowledge and pedagogical judgment (Trust & Whalen, 2020; UNESCO, 2023). This process highlights the importance of recognizing teachers' experiential knowledge and professional agency when designing digital education policies and professional development programmes (European Commission, 2022; OECD, 2023). It also suggests that future reforms should prioritize sustainable pedagogical ecosystems rather than technology deployment alone, particularly by strengthening infrastructure, institutional support, teacher training, and collaborative professional cultures (OECD, 2023; UNESCO, 2023). In this perspective, supporting teachers' agency appears essential for ensuring that digital innovation contributes meaningfully to the quality, equity, and sustainability of education in Tunisian public secondary schools (UNESCO, 2023).

4. DISCUSSION

The present study explored teachers' digital practices within Tunisian public secondary schools and revealed the complex and uneven nature of educational digital transformation in a context characterized by structural inequalities, institutional constraints, and differences in teachers' professional resources. Overall, the findings indicate that digital technology integration cannot be understood exclusively in terms of access to devices or teachers' technical competencies. Rather, it is embedded in broader socio-economic, organizational, pedagogical, and professional conditions. This interpretation is consistent with critical approaches to educational technology, which emphasize that digitalization is a socially and institutionally situated process rather than a neutral or purely technical intervention (Selwyn, 2022). Similarly, the UNESCO (2023) Global Education Monitoring Report stresses that technology does not automatically improve educational outcomes and that its educational value depends largely on contextual conditions, teacher preparedness, equity, and appropriate pedagogical use.

4.1. Structural Constraints and Persistent Digital Inequalities

One of the most significant findings concerns the persistence of structural barriers to the effective integration of digital technologies. Participants repeatedly reported inadequate technological infrastructure, unstable internet connectivity, insufficient equipment, and unequal access to digital resources across schools. These findings are consistent with international evidence showing that disparities in access to digital technologies continue to constitute a major challenge for equitable educational transformation (UNESCO, 2023; OECD, 2023). The issue is therefore not simply whether schools possess digital technologies, but whether teachers and students can access them reliably and use them under sufficiently supportive conditions. The findings also support the multidimensional conception of the digital divide proposed by Van Dijk (2020). From this perspective, digital inequality encompasses not only physical access to technological devices and connectivity but also differences in skills, patterns of use, motivation, and the social and institutional resources available to individuals. In the present study, inequalities were visible not only in the availability of equipment but also in the conditions under which teachers could integrate digital tools into their teaching. Teachers working in rural and semi-urban schools particularly emphasized difficulties related to connectivity, equipment availability, and technical maintenance. Such territorial differences suggest that digital transformation may reproduce or intensify existing educational inequalities when technological policies are implemented without sufficient attention to local conditions. The results further indicate that structural inequalities extend beyond material resources to include professional support and training opportunities. Teachers reported that access to professional development was uneven and that formal training did not always correspond to their practical classroom needs. This observation is consistent with research showing that teachers' digital competence develops most effectively when professional learning is continuous, collaborative, practice-oriented, and embedded within teachers' everyday pedagogical contexts (Tondeur et al., 2021). The OECD (2023) similarly emphasizes that effective digital education requires an ecosystem involving infrastructure, teacher competence, organizational support, leadership, and appropriate pedagogical frameworks. Consequently, the findings suggest that providing technological equipment without simultaneously strengthening teachers' professional development is unlikely to produce sustainable pedagogical transformation.

4.2. Policy Expectations and Pedagogical Realities

The Tunisian context appears to be characterized by a tension between institutional expectations concerning digital modernization and the practical conditions in which teachers are expected to implement these reforms. Teachers are encouraged to diversify their pedagogical practices through digital technologies, yet they may have limited access to reliable infrastructure, training, technical assistance, or sufficient preparation time. This discrepancy between policy ambitions and classroom realities has also been documented internationally. Tondeur et al. (2021), for example, demonstrate that teachers' technology integration is strongly influenced by contextual factors, including institutional support, leadership, professional development, and access to resources. This finding is important because it challenges approaches that attribute successful digital integration primarily to individual teacher competence. While teachers' knowledge and attitudes are undoubtedly important, the literature indicates that technology

integration is also shaped by school-level and system-level conditions (OECD, 2023; UNESCO, 2023). In this respect, the present findings suggest that Tunisian teachers are operating within a policy environment in which responsibility for digital innovation may exceed the resources available to them.

Digital transformation can therefore generate a form of implementation gap: technological modernization may be promoted at the policy level while its practical realization remains dependent on teachers' capacity to negotiate local constraints. The findings consequently support a more ecological understanding of digital transformation. Rather than considering teachers' digital practices as isolated individual behaviors, they should be interpreted as situated practices emerging from interactions between teachers, students, technologies, school environments, institutional policies, and available resources. Such an interpretation is compatible with the broader ecological perspective on teacher agency developed by Priestley et al. (2015), according to which teachers' professional actions are shaped by the interaction between individual capacities, past experiences, professional orientations, and structural and cultural contexts.

4.3. Teacher Agency, Adaptation, and Professional Resilience

Despite the structural constraints identified above, an important finding of the study is the considerable professional agency demonstrated by participating teachers. Teachers did not simply abandon digital practices when institutional conditions were unfavorable. Instead, many developed adaptive strategies, including the use of personal smartphones and laptops, private internet connections, self-directed learning, and informal exchanges with colleagues. These practices demonstrate teachers' willingness to maintain and develop digital pedagogies despite contextual limitations. This finding is consistent with Priestley et al.'s (2015) conception of teacher agency as an achievement emerging from the interaction between individual capacities and contextual resources. Teachers' agency should therefore not be interpreted simply as an individual personality characteristic or willingness to innovate. Rather, it is enabled or constrained by the professional environment in which teachers work. The present findings provide empirical support for this perspective: teachers were able to innovate precisely because they mobilized personal knowledge, previous experiences, social relationships, and available technologies to compensate for institutional limitations.

However, the reliance on personal resources also raises an important issue concerning the sustainability and equity of digital innovation. When teachers use their own devices, internet subscriptions, and personal time to compensate for infrastructural deficiencies, individual commitment may temporarily reduce the effects of institutional shortcomings, but it does not resolve the underlying structural problem. UNESCO (2023) similarly warns that digitalization may deepen inequalities when access to technology and support depends on individual or institutional resources. Thus, teacher agency should be recognized and supported rather than used as a substitute for adequate institutional provision. The findings therefore challenge deterministic perspectives in which teachers are represented merely as passive implementers of technological reforms. Teachers appear instead as active actors who interpret, negotiate, adapt, and sometimes transform institutional expectations according to their local circumstances. This dimension represents an important contribution of the study because it highlights the role of teachers' situated professional knowledge in shaping digital transformation.

4.4. Collaboration and Informal Professional Learning

Another significant finding concerns the development of informal forms of collaboration among teachers. Participants described exchanging digital resources, sharing practical advice, supporting colleagues, and collectively solving technological and pedagogical problems. These practices became particularly important when formal professional development opportunities were perceived as insufficient. This finding is consistent with research emphasizing the importance of professional learning networks and collaborative cultures in developing teachers' digital competencies (Trust et al., 2016). Digital competence is not necessarily acquired exclusively through formal training programmes; it can also emerge through peer interaction, experimentation, collaborative problem-solving, and participation in professional networks. Such informal learning may be particularly significant in contexts where institutional training opportunities are limited. The findings consequently suggest that schools should not be viewed merely as places where

digital technologies are implemented, but also as professional environments in which teachers collectively construct knowledge about technology use. This interpretation extends the discussion beyond individual digital competence toward the organizational conditions that facilitate professional learning. OECD (2023) similarly emphasizes the importance of developing coherent digital education ecosystems in which teachers, school leaders, institutions, and technological infrastructures operate in a coordinated manner.

4.5. Situated Appropriation of Digital Technologies

The findings also indicate that teachers developed forms of digital appropriation adapted to students' socio-economic conditions and the resources available in their schools. Rather than implementing standardized technological models, participants selected and adapted tools according to their perceived usefulness, accessibility, and feasibility. Digital technologies were frequently employed for practical purposes such as accessing learning materials, sharing resources, maintaining communication, illustrating scientific concepts, and increasing student engagement. This pragmatic orientation is consistent with critical perspectives on educational technology that question technology-driven approaches to educational reform (Selwyn, 2022). From this perspective, technologies should not be regarded as inherently transformative. Their educational effects depend on how they are appropriated by teachers and learners within specific social and pedagogical contexts. UNESCO (2023) similarly argues that educational technologies should serve clearly defined pedagogical purposes rather than become ends in themselves. The present findings therefore support the idea that meaningful digital integration is primarily pedagogical rather than technological. Teachers appear to make decisions about technology according to classroom needs rather than simply adopting tools because they are innovative. This situated appropriation is particularly important in contexts characterized by unequal access and limited resources because it allows teachers to identify relatively accessible technological solutions that can nevertheless support learning.

4.6. Digital Technologies and Emerging Pedagogical Transformations

The study further demonstrates that digital technologies have contributed to gradual changes in teaching practices and classroom interactions. Teachers reported increased student engagement, greater access to multimedia resources, diversification of instructional strategies, and new possibilities for communication and collaboration. Multimedia resources, educational videos, online materials, and communication platforms were perceived as facilitating more dynamic learning experiences. These findings are broadly consistent with research suggesting that digital technologies can support learner-centered and interactive pedagogies when they are integrated within coherent instructional designs (Redecker, 2020). However, the present findings also indicate that these transformations should not be interpreted as evidence of an automatic transition toward innovative pedagogy. The use of a digital tool does not necessarily imply a transformation of the underlying pedagogical model. UNESCO (2023) similarly cautions against assuming that the mere introduction of technology necessarily produces improved teaching and learning. The contribution of digital technologies in the present study therefore appears to be gradual rather than revolutionary. Teachers reported changes in the ways they present information, communicate with learners, provide resources, and stimulate participation. Yet these changes coexist with more traditional teaching approaches. This coexistence suggests that digitalization may initially modify particular aspects of classroom practice without completely replacing established pedagogical routines.

4.7. The Fragility and Unevenness of Digital Innovation

Although the findings reveal several positive transformations, they also demonstrate the fragile and uneven nature of these innovations. Many digital practices depended on individual motivation, personal experimentation, and teachers' willingness to invest additional time and resources. This situation creates a paradox: teacher agency facilitates innovation, but excessive reliance on individual agency may make such innovation difficult to sustain. This finding is consistent with the literature emphasizing that sustainable educational change requires organizational and institutional support rather than relying exclusively on individual teachers (Fullan et al., 2020; OECD, 2023). Without appropriate infrastructure, professional development, technical support, preparation time, and recognition, innovative practices may remain

isolated and vulnerable to interruption. The findings also raise questions about workload and professional well-being. When teachers must learn new technologies independently, troubleshoot technical problems, prepare digital resources, and provide additional forms of communication with students, digitalization may increase rather than reduce professional demands. Consequently, digital transformation should be accompanied by organizational measures that recognize the additional work involved in developing and maintaining digital pedagogies.

4.8. The COVID-19 Pandemic as an Accelerator of Digital Appropriation

The COVID-19 pandemic represents another important dimension emerging from the findings. Participants described the pandemic as a period of disruption but also as an accelerator of digital appropriation. The sudden shift toward remote and hybrid forms of teaching required teachers to acquire new digital skills rapidly and to experiment with alternative forms of communication and instruction. This observation is consistent with international research conducted during the pandemic. Bozkurt and Sharma (2020) characterized emergency remote education as a rapid and improvised response to an unprecedented crisis, while Dhawan (2020) highlighted both the opportunities and limitations associated with online education during the pandemic. The present findings similarly suggest that the pandemic accelerated teachers' exposure to digital environments but did not eliminate the structural inequalities that affected their ability to use these technologies effectively. The pandemic should therefore be understood less as the origin of digital transformation than as a catalyst that intensified an already emerging process. Teachers' experiences during this period appear to have contributed to the development of new competencies and greater familiarity with digital tools. At the same time, the difficulties reported by participants demonstrate that crisis-driven digitalization cannot replace long-term educational planning, infrastructure development, and sustained professional development.

4.9. Implications for Educational Policy and Practice in Tunisia

From a broader perspective, the findings contribute to current debates concerning educational digitalization in Global South contexts. They suggest that technology-based educational reforms cannot simply be transferred from one context to another without considering differences in infrastructure, socio-economic conditions, institutional capacity, and teachers' professional cultures. Selwyn (2022) emphasizes the importance of critically examining the social and political conditions surrounding educational technologies, while UNESCO (2023) highlights the need to ensure that technology contributes to inclusion rather than reinforcing existing inequalities. In the Tunisian context, these findings indicate that sustainable digital transformation requires coordinated action at several levels. At the infrastructural level, schools need reliable connectivity, appropriate equipment, and effective technical maintenance. At the professional level, teachers require continuous and context-sensitive professional development that connects technological competencies with concrete pedagogical needs. At the organizational level, schools need collaborative cultures that enable teachers to share resources, experiment, and learn from one another. At the policy level, teachers should be more directly involved in the design and implementation of digital education reforms. The importance of teacher participation is particularly relevant in light of the findings concerning professional agency. If teachers are treated only as recipients of externally designed technological reforms, digital policies may fail to respond to classroom realities. Conversely, recognizing teachers as professional actors with situated knowledge can contribute to the development of more realistic and sustainable reforms. This position is consistent with the ecological conception of teacher agency proposed by Priestley et al. (2015) and with broader perspectives on sustainable educational change emphasizing participation, collaboration, and institutional capacity (Fullan et al., 2020).

4.10. Overall Interpretation and Contribution of the Study

Taken together, the findings demonstrate that digital transformation in Tunisian public secondary schools is neither absent nor fully achieved. Rather, it is an ongoing, uneven, and negotiated process situated between structural constraints and teachers' professional agency. The results suggest that teachers are actively constructing locally appropriate forms of digital practice while simultaneously working within

conditions that limit the scale and sustainability of these innovations. The study therefore contributes to the literature by highlighting the importance of moving beyond a technology-centered understanding of digital transformation. Digitalization should instead be considered simultaneously as a technological, pedagogical, organizational, and professional process. The availability of digital tools creates possibilities, but these possibilities become educationally meaningful only when teachers have the resources, knowledge, institutional support, and professional autonomy required to transform technological affordances into pedagogically relevant practices (OECD, 2023; UNESCO, 2023). Overall, the findings support a gradual and situated conception of digital transformation rather than the idea of a complete pedagogical revolution. Digital technologies are progressively influencing how teachers access and share resources, communicate with students, organize learning activities, and diversify instructional practices. Nevertheless, these developments remain dependent on individual commitment and contextual opportunities. Sustainable transformation therefore requires moving beyond reliance on teacher resilience toward the establishment of supportive educational ecosystems characterized by reliable infrastructure, continuous professional learning, collaborative cultures, equitable access, and participatory governance (OECD, 2023; UNESCO, 2023).

In this respect, the Tunisian experience illustrates a broader principle identified in international research: educational technologies do not transform schools independently of the people and institutions that use them. Their effects are mediated by teachers' professional knowledge, students' circumstances, school environments, and educational policies (Selwyn, 2022; Van Dijk, 2020). The contribution of digital transformation will therefore depend not simply on how much technology is introduced into schools, but on how effectively educational systems create the conditions under which teachers and learners can appropriate these technologies in meaningful, equitable, and sustainable ways.

5. CONCLUSIONS

This study explored teachers' digital practices within Tunisian public secondary schools, with particular attention to the relationship between structural constraints and contextual adaptation strategies. The findings demonstrate that the integration of digital technologies into educational practices remains deeply influenced by unequal institutional conditions, limited technological infrastructure, insufficient professional development opportunities, and broader socio-economic disparities. Although educational policies increasingly promote digital transformation as a strategic priority, the realities observed in schools reveal significant gaps between institutional ambitions and the everyday conditions in which teachers work (UNESCO, 2023; OECD, 2023). The study highlights that teachers operate within educational environments characterized by unstable internet connectivity, unequal access to digital resources, limited technical support, and organizational pressures that often restrict the development of innovative pedagogical practices. These structural limitations contribute to differentiated forms of digital integration across schools and regions and may reinforce existing educational inequalities (Van Dijk, 2020; Selwyn, 2022). However, the findings also demonstrate that teachers are not passive recipients of digital reforms. Rather, they exercise professional agency, creativity, and adaptive capacity in responding to institutional constraints. Through the use of personal technological resources, collaborative professional networks, informal learning strategies, and flexible pedagogical practices, teachers actively negotiate and reinterpret digital transformation processes within their local contexts (Priestley et al., 2015; Trust et al., 2016).

The research further shows that digital technologies can contribute to the diversification of pedagogical practices, the reinforcement of student engagement, and the development of more interactive learning environments when teachers are able to appropriate technologies in meaningful and context-sensitive ways (Redecker, 2020; Fullan et al., 2020). Nevertheless, these innovations remain fragile when they depend primarily on individual commitment rather than sustainable institutional support. Digitalization in education should therefore not be reduced to a technical modernization process centered on equipment acquisition alone. Effective and equitable digital transformation requires coherent educational policies that integrate infrastructural investment, continuous professional development, pedagogical support, technical assistance, and social inclusion within a long-term strategic framework (OECD, 2023; UNESCO, 2023). From a scientific perspective, this research contributes to current debates on educational digital transformation in Global South contexts by emphasizing the situated and socially embedded nature of teachers' digital practices. The Tunisian case illustrates how educational actors

reinterpret global digital reforms according to local institutional realities, material conditions, and professional experiences. The findings support critical perspectives suggesting that successful ICT integration depends not only on technological access but also on institutional equity, contextual adaptation, and recognition of teachers' experiential knowledge (Selwyn, 2022; Tondeur et al., 2021). The study also reinforces the importance of considering teachers as central actors in educational innovation processes rather than merely as implementers of externally designed reforms (Ertmer & Ottenbreit-Leftwich, 2010). In addition, it contributes empirical evidence to the growing literature on digital education in North African contexts, which remain comparatively underrepresented in international educational research. The findings have important implications for educational policy and professional development in Tunisia. Reducing infrastructural inequalities between schools and regions, ensuring reliable access to digital resources, and developing continuous professional development programs focused on the pedagogical integration of technologies should constitute key priorities. Such training should move beyond technical competencies and address lesson design, digital pedagogy, assessment, collaborative learning, digital inclusion, and the critical evaluation of digital resources (Redecker, 2022). Furthermore, strengthening collaborative professional cultures and participatory forms of educational governance may contribute to more sustainable and inclusive forms of pedagogical innovation (Fullan, 2013; Trust et al., 2016). Digital reforms should therefore be developed in closer dialogue with teachers and should take into account the material, organizational, and pedagogical realities of schools.

Despite these contributions, several limitations should be acknowledged. First, the contextual specificity of the selected schools limits the extent to which the findings can be transferred to other educational settings. The participating schools operate within particular institutional, technological, socio-economic, and regional conditions, and teachers' experiences of digital transformation may differ substantially in schools with different levels of infrastructure, administrative support, or access to digital resources. Consequently, the findings should be interpreted primarily as a contextually grounded account of teachers' digital practices rather than as a statistically representative description of all Tunisian secondary schools. Second, the size and composition of the sample constitute another limitation. The study focused on a relatively limited group of teachers and did not include all categories of educational stakeholders involved in digital transformation. The perspectives of students, school administrators, inspectors, policymakers, parents, and technical staff were not systematically incorporated. This limits the possibility of examining digital transformation as a multidimensional process involving actors with potentially different experiences, expectations, and interpretations. Future research should therefore involve larger and more heterogeneous samples, including participants from different regions, school types, disciplinary backgrounds, levels of teaching experience, and socio-economic contexts. Such sampling would make it possible to identify both common patterns and context-specific variations in teachers' digital practices.

Third, as with other qualitative studies based substantially on participants' accounts and researcher-led interpretation, researcher interpretation bias cannot be entirely excluded. The processes of coding, thematic categorization, and interpretation inevitably involve analytical judgments, particularly when examining complex and context-dependent phenomena such as professional agency and pedagogical adaptation. Although systematic analytical procedures and triangulation were used to strengthen the credibility of the findings, future studies could further reduce this potential bias through additional strategies, including inter-coder comparison, independent coding by multiple researchers, member checking, reflexive journals, and the integration of more extensive observational or documentary evidence. Fourth, the limited generalizability of qualitative findings represents an important methodological constraint. The purpose of the study was to develop an in-depth understanding of teachers' experiences and practices rather than to produce statistically generalizable conclusions. Therefore, the patterns identified should not be assumed to apply uniformly across the Tunisian education system or to other national contexts. Nevertheless, the findings may provide analytical insights that can inform further investigations in comparable contexts. Future studies using larger samples and mixed-methods designs could complement the present qualitative evidence with quantitative measures capable of examining the prevalence and distribution of the identified patterns across different regions and school populations (Creswell & Plano Clark, 2018).

These limitations directly suggest several directions for future research. First, future investigations should adopt broader and more diversified sampling strategies to examine whether the patterns identified in the present study are also observed across different Tunisian regions, school environments, and socio-

economic contexts. Comparative research between urban and rural schools, better-resourced and under-resourced institutions, and public and private schools would be particularly valuable for identifying the structural factors that facilitate or constrain digital integration. Second, future research should adopt multi-stakeholder and multi-perspective approaches. Including students, school leaders, inspectors, policymakers, parents, and technical personnel would make it possible to compare teachers' perceptions with those of other actors and to develop a more comprehensive understanding of how digital transformation is negotiated at different levels of the education system. Longitudinal studies would also be useful for examining how teachers' digital practices and professional identities evolve as infrastructure, policies, and professional development opportunities change over time. Third, future studies should combine qualitative and quantitative approaches. Large-scale questionnaires could be used to assess the prevalence of digital practices, levels of access, professional development needs, and regional inequalities, while interviews and classroom observations could provide deeper explanations of the mechanisms underlying these patterns. Such mixed-methods designs would strengthen the empirical basis for assessing the relationship between structural conditions, teacher agency, professional development, and pedagogical innovation. Fourth, future research should strengthen methodological reflexivity and validation procedures. The use of multiple researchers during coding, independent analytical comparisons, participant validation, and systematic triangulation of interviews, observations, and institutional documents could further enhance the credibility and dependability of findings.

Classroom-based research should also be expanded in order to compare what teachers report about their digital practices with what actually occurs during teaching and learning activities. Finally, future research should examine the long-term consequences of digital transformation, particularly in the post-pandemic period. Longitudinal investigations could explore whether teachers' current adaptive practices become institutionalized, whether professional development produces sustained changes in pedagogical practice, and whether digitalization contributes to reducing or reproducing educational inequalities (Dhawan, 2020; Bozkurt & Sharma, 2020). Such research would be particularly relevant for Tunisia, where digital transformation remains closely connected to broader questions of educational equity, regional disparities, and institutional capacity. Overall, this study demonstrates that teachers' digital practices in Tunisia emerge at the intersection of structural constraints, contextual adaptation, and professional agency. The findings underline that sustainable digital transformation requires not only technological investment but also social equity, institutional support, professional development, and recognition of teachers' capacities to innovate within complex educational environments. Educational digitalization should therefore be understood as a multidimensional process in which technological resources interact with institutional structures, professional cultures, pedagogical practices, and local socio-economic conditions (Selwyn, 2022; UNESCO, 2023). The Tunisian case ultimately suggests that successful digital transformation cannot be achieved through top-down technological provision alone. It requires educational reforms that are responsive to local realities and that actively involve teachers in the design, implementation, and evaluation of digital policies. By placing teachers' experiences and professional agency at the center of digital transformation, policymakers and educational institutions may develop more equitable, sustainable, and context-sensitive approaches to educational innovation. Future research building on the limitations identified above will be essential for determining the extent to which these findings can be transferred across Tunisian educational contexts and for identifying the conditions under which digital technologies can genuinely contribute to improving the quality and equity of education.

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Data Availability Statement. The data supporting the findings of this study are available from the corresponding author upon reasonable request. Due to ethical and confidentiality considerations concerning participants' identities and institutional privacy, the full interview transcripts and observation notes are not publicly available.

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