



Post-COVID Professional Digital Competence in Higher Education

Operational Strengths, Pedagogical Gaps, and Persistent Barriers among University Teachers in Islamabad

¹Misbah Shafait Abbasi*, ¹Yu Rong

Affiliations:

¹ Zhejiang Normal University, Jinhua, China

*Correspondence: misbahshafaitabbasi@gmail.com

ABSTRACT

Post-COVID higher education requires educators who can integrate digital technologies pedagogically, not merely operate them. This cross-sectional study assessed self-reported professional digital competence and perceived barriers among 242 teachers at Quaid-i-Azam University, Islamabad. Strongest reported domains were digital communication (96%), file and cloud management (92%), ICT-supported assessment (84.3%), and general digital-tool use (83.3%), whereas virtual learning environment use (32%) and advanced information retrieval (56%) were weaker. Infrastructure, technology quality, time and cost, online materials, and feedback remained major barriers. The findings support a shift from basic tool training toward pedagogical integration, VLE-based course design, digital assessment, information literacy, and sustained institutional support.

Keywords

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Introduction

The COVID-19 pandemic forced higher education institutions to move rapidly from campus-based teaching to remote and digitally mediated instruction. In the post-COVID period, the central issue is no longer whether university teachers can access digital technologies, but

whether they can integrate them pedagogically, critically, and sustainably. The European Framework for the Digital Competence of Educators (DigCompEdu) conceptualizes educator digital competence as a combination of professional engagement, digital-resource use, teaching and learning, assessment, learner empowerment, and support for learners' own digital competence [1]. Recent higher-education scholarship similarly argues that digital competence must be understood as a professional capability that connects technology use with disciplinary teaching, learning design, assessment, communication, and organizational practice [2]–[4].

This broader conception is important because earlier research repeatedly showed that access to information and communication technologies (ICT) does not automatically produce pedagogically meaningful integration. Systematic evidence has identified insufficient training and uneven professional-development opportunities as persistent obstacles to teachers' digital competence [5]. Professional learning for ICT integration is most effective when it is connected to local practice, collaboration, reflection, and institutional conditions rather than delivered as isolated technical training [6]. Likewise, long-term digital transformation depends on balancing technology-driven change with pedagogical and organizational change [7]. Professional digital competence (PDC) therefore extends beyond generic operational skills and includes the capacity to mobilize digital technologies in relation to learners, disciplinary knowledge, pedagogical aims, and professional values [8]–[10].

Teacher education research has also shown that digital competence develops unevenly. Newly qualified teachers may be confident users of everyday technologies while remaining less prepared for professional teaching tasks [11]. Transformative digital agency requires teachers to adapt technologies to educational problems rather than merely reproduce existing routines [12]. Studies of teacher education have consequently called for stronger integration of professional digital competence into programmes, curricula, and practicum experiences [13], [14], while online teacher-education research demonstrates that even digitally delivered programmes may fail to develop PDC when technology is not explicitly connected to pedagogical practice [15]. In higher education, faculty adoption of learning management systems (LMSs) is further shaped by system quality, self-efficacy, perceived usefulness, and facilitating conditions [16].

Institutional culture and infrastructure are equally important. School-level research indicates that sustained ICT integration is associated with leadership, digital-content practices, communication, and teachers' competence [17], while classic barrier studies identify time, technical support, leadership, training, and access to resources as central implementation conditions [18]. Digital literacy research also distinguishes basic access from more advanced practices of information evaluation, retrieval, creation, and participation [19]. Differences in digital self-perception may occur across demographic and professional groups [20], and self-

efficacy is not equivalent to objectively demonstrated competence [21]. Studies of teacher preparation therefore emphasize the need to assess competence in multiple domains rather than reduce digital readiness to a single score [22].

Digital competence also intersects with assessment, distance learning, and professional transformation. ICT-based assessment can support formative and summative evaluation, learning analytics, portfolios, and feedback when teachers possess appropriate assessment literacy [23]. LMSs can extend teaching beyond time and place, but their educational value depends on how teachers use communication, monitoring, content, and assessment functions [24]. Competence-based professional development, including digital badges and structured pathways, provides one approach to making teacher learning visible and progressive [25]. Earlier digital-literacy work also shows that multimedia participation, creation, and navigation require more than software operation [26]. From a higher-education perspective, digital transformation may involve threshold changes in professional identity and pedagogical understanding [27], [28], while responsive teaching in diverse settings requires attention to context, learner needs, and instructional adaptation [29], [30].

These issues remain highly relevant after the pandemic. Recent studies of higher-education teachers indicate that the competencies required for sustainable post-pandemic digital education extend beyond technical skills to professional, pedagogical, and organizational capabilities [31]. DigCompEdu-based evidence also shows that competence levels vary by teacher and professional characteristics [32], while systematic reviews caution that the field still lacks consistent operationalization and comparable measurement of teacher digital competence [33]. Evidence from South Asian higher education remains comparatively limited, particularly at the level of university faculty and post-COVID teaching practice. The present study therefore re-examines survey data from Quaid-i-Azam University, Islamabad, to identify areas of operational strength, pedagogical weakness, and perceived institutional barriers.

The study had two primary objectives: (1) to assess the self-reported professional digital competence of university teachers across major functional domains, and (2) to identify the principal barriers perceived by teachers in digitally mediated teaching and learning. A secondary descriptive objective was to examine patterns of digital competence across faculties in order to provide a broader institutional perspective. However, because the source manuscript contained internally inconsistent faculty-level percentages and discrepancies in the reported ANOVA results, this revised article does not make formal claims regarding statistically significant differences between faculties. Instead, faculty-level findings are presented descriptively and interpreted cautiously to preserve analytical transparency, avoid unsupported statistical conclusions, and ensure that the reported results remain consistent with the available evidence.

Material and Methods

A. Design, Setting, and Participants

A quantitative cross-sectional descriptive survey was conducted among teachers at Quaid-i-Azam University, Islamabad. The source manuscript reported a population of 635 male and female teachers across university faculties. A sample of 242 teachers was selected using stratified random sampling. The manuscript stated that the sample size followed a standard sample-size table, but it did not provide the bibliographic source for that table; therefore, that specific sample-size justification is not independently claimed here. Data were collected online through Google Forms from university departments. The final analytic sample comprised all 242 respondents reported in the source dataset.

B. Instrument and Measures

The questionnaire combined five-point Likert items (1 = Strongly Disagree to 5 = Strongly Agree) with dichotomous Yes/No items. The measurement content covered: general digital-tool operation; digital assessment; information search and retrieval; file and cloud management; digital communication; content sharing; virtual learning environment (VLE) use; common productivity and media software; digital tools for organizing teaching; and perceived barriers to online and digitally supported teaching. The item content broadly reflects dimensions represented in DigCompEdu and in prior research on professional digital competence, LMS use, digital literacy, and ICT-supported assessment [1], [8], [16], [19], [23], [24].

The source manuscript reported Cronbach's alpha coefficients of 0.781 for the level-of-PDC scale, 0.743 for the digital-tools scale, 0.890 for the professional-development/training scale, and 0.611 for the challenges scale. The first three coefficients indicate acceptable to strong internal consistency for exploratory survey use, whereas the challenges subscale should be interpreted more cautiously because its alpha is comparatively low.

C. Data Analysis and Consistency Audit

Descriptive statistics were used to summarize respondent characteristics and item responses. For the 12-item digital-tool scale, the revised analysis reports the mean percentage of respondents selecting Agree or Strongly Agree across the reported items. For Yes/No domains, the mean affirmative response across the items in each domain is reported. These summary percentages were calculated directly from the item-level percentages available in the source manuscript and should therefore be interpreted as descriptive aggregates rather than latent-scale scores.

Before reconstructing the manuscript, we checked the reported results for internal consistency. We did not retain two one-way ANOVA tables for inferential interpretation because both reported between-group $df = 1$ while the accompanying text described comparisons across

multiple faculties, and the narrative conclusions reversed the logic of the reported p-values. In addition, one faculty profile row summed to 110%, and faculty-specific sample sizes were not reported. Accordingly, the revised article does not claim statistically significant faculty differences. Faculty-level patterns are treated as exploratory descriptive evidence only.

Results

A. Respondent Profile

The sample included 144 men (60%) and 98 women (40%). Half of the respondents were aged 41–50 years, 30% were aged 30–40 years, and 20% were younger than 30 years. No respondent was reported in the 51-years-and-above category. Teaching tenure was concentrated between 5 and 10 years (40%), followed by 3–5 years (30%), more than 10 years (20%), and 2–3 years (10%). These distributions indicate an experienced mid-career sample rather than an early-career faculty cohort.

Table 1. Respondent characteristics (N = 242).

Characteristic	Category	N	%
Gender	Male	144	60
	Female	98	40
Age	<30 years	48	20
	30–40 years	73	30
	41–50 years	121	50
	≥51 years	0	0
	1–2 years	0	0
Teaching tenure	2–3 years	24	10
	3–5 years	73	30
	5–10 years	97	40
	>10 years	48	20

B. Functional Profile of Professional Digital Competence

The most important finding was the uneven distribution of digital competence across functional domains. University teachers reported relatively strong competence in routine operational activities, whereas platform-based course management and advanced information-search practices were notably weaker. Across the 12 Likert-scale items assessing general digital-tool operation, the mean proportion of positive responses (*Agree + Strongly Agree*) was 83.3%, indicating generally high confidence in basic digital activities. In the dichotomous Yes/No sections, the strongest domains were file and cloud management (92%), digital communication (96%), and ICT-supported assessment (84.3%). In contrast, affirmative responses were considerably lower for virtual learning environment (VLE) use (32%), advanced information retrieval (56%), software use (66%), and digitally supported teaching management (65%). These findings suggest that teachers were generally proficient in commonly used digital functions but

demonstrated more limited competence in specialized, pedagogically integrated, and platform-dependent practices.

Table 2. Descriptive summary of reported digital-competence domains.

Domain	Items	Summary indicator	Reported level
1. General digital-tool operation	12 Likert items	Mean Agree + Strongly Agree	83.3%
2. ICT-supported assessment	7 Yes/No items	Mean Yes	84.3%
3. Information search and retrieval	5 Yes/No items	Mean Yes	56.0%
4. File and cloud management	5 Yes/No items	Mean Yes	92.0%
5. Digital communication	5 Yes/No items	Mean Yes	96.0%
6. Sharing digital content	5 Yes/No items	Mean Yes	70.0%
7. Virtual learning environment use	5 Yes/No items	Mean Yes	32.0%
8. Productivity/media software	5 Yes/No items	Mean Yes	66.0%
9. Digital teaching management	4 Yes/No items	Mean Yes	65.0%

Note: Domain percentages are descriptive aggregates calculated from the rounded item-level percentages reported in the source manuscript.

Item-level patterns reinforce this distinction. Nearly all respondents reported using basic communication technologies, cloud storage, file transfer, and common search engines. In contrast, only 20% reported using quotation marks for exact searches and 30% searched in more than one language. VLE use was consistently low: only 30–40% reported using VLEs to organize documents, manage classes, conduct learning activities beyond the classroom, adapt a VLE to programme needs, or conduct assessment. Image-editing competence was also limited, with only 10% reporting use of image-editing software.

C. Perceived Barriers to Sustainable Digital Teaching

Perceived barriers remained substantial despite generally strong competence in routine digital operations. Across the eight negatively worded items assessing challenges in digitally mediated teaching and learning, the mean proportion of respondents selecting *Agree* or *Strongly Agree* was 87.5%, indicating that difficulties were widely experienced. The most prominent barriers were insufficient technological infrastructure and resources, concerns regarding the quality and reliability of digital technologies, and the time and financial costs associated with professional development, with 100% agreement recorded for each item. In addition, 90% of respondents reported difficulties related to the availability and relevance of online course materials, perceptions that online teaching was less effective than conventional face-to-face instruction, and inadequate feedback during online teaching. These findings indicate that high levels of basic digital competence did not necessarily eliminate structural, pedagogical, and institutional constraints affecting the effective integration of digital technologies into university teaching.

Table 3. Reported barriers to digitally mediated teaching.

Barrier statement	Agree + Strongly Agree	Interpretive emphasis
1. Relevant course materials are not available for online classes	90%	Content/resources
2. Online teaching does not teach course material better than traditional classes	90%	Pedagogical confidence
3. No prior experience using technology for online teaching	50%	Experience
4. Dissatisfaction with e-learning content	80%	Content quality
5. Insufficient feedback during online classes	90%	Interaction/feedback
6. Time and economic costs constrain professional development	100%	Professional development
7. Quality limitations of digital technologies in teaching and learning	100%	Technology quality
8. Lack of technological infrastructure and resources	100%	Infrastructure

D. Descriptive Faculty Patterns and Statistical Caution

The source manuscript described considerable faculty variation, with Engineering and Technology reporting the largest share of teachers in the expert category (60%), while Arabic reported no respondents at the expert level. However, these faculty percentages cannot support a valid inferential conclusion because faculty-specific sample sizes were not supplied and at least one row was internally inconsistent. The accompanying ANOVA tables were likewise incompatible with the stated nine-faculty comparison. The revised manuscript therefore treats apparent faculty differences as a signal for future investigation rather than as a statistically established result.

Discussion

The study reveals a post-COVID competence profile characterized by operational strength but pedagogical and infrastructural fragility. Teachers were highly confident in routine functions such as communication, file management, cloud storage, basic digital assessment, and common productivity tools. This pattern is consistent with the distinction between generic digital fluency and professional digital competence: being able to operate technologies does not necessarily mean being able to design, orchestrate, and evaluate technology-rich learning [1], [8], [10]. Recent higher-education frameworks similarly emphasize that sustainable digital teaching requires competencies in learning design, assessment, inclusion, learner engagement, and professional collaboration, not only technical execution [2]–[4].

The clearest gap concerns VLE use. Although communication and file-sharing practices were widespread, only about one-third of respondents reported using VLE functions for class management, extended learning activities, programme adaptation, or assessment. This echoes earlier LMS research showing that availability and adoption do not guarantee full use of pedagogically consequential functions [16], [24]. It also supports findings from teacher-

education research in which digital technologies were often present but weakly integrated into the professional core of teaching [13]–[15]. In practical terms, professional development at the university should therefore prioritize course architecture, asynchronous interaction, formative assessment, learning analytics, feedback workflows, and the alignment of digital activities with learning outcomes rather than generic software workshops.

Information literacy constitutes a second weakness. Respondents were universally familiar with keyword searching, but more advanced search strategies were uneven. This matters because digital competence includes the ability to locate, evaluate, organize, and use information critically [19], [21]. It also affects teachers' ability to model scholarly search practices for students. Digital literacy research has long shown that meaningful participation in digital environments involves navigation, evaluation, creation, and communication rather than simple access [26]. In a higher-education context, the shift from emergency online teaching to mature blended learning should therefore include advanced information-retrieval skills and digital-source evaluation as explicit components of faculty development.

The high barrier scores indicate that competence development cannot be treated as an individual responsibility alone. Respondents simultaneously reported strong everyday tool use and major constraints related to infrastructure, technology quality, time, costs, course materials, and feedback. This combination is consistent with research showing that sustainable ICT integration depends on institutional conditions, leadership, technical support, collaborative professional learning, and protected time [6], [17], [18]. The post-pandemic evidence is particularly relevant: universities that wish to preserve useful digital practices need institutional structures that support both digital and professional competence development [31].

The results should also be interpreted in light of self-report measurement. Research has shown that ICT self-efficacy and objectively assessed information literacy are related but distinct [21]. Accordingly, the strong percentages for routine tools should be read as perceived competence and reported practice, not direct performance testing. The relatively low Cronbach's alpha for the challenge scale (0.611) adds further uncertainty to fine-grained interpretation. More recent measurement research emphasizes the need for clearer operationalization and stronger comparability across teacher-digital-competence studies [33]. Future research in Pakistan should therefore combine self-report instruments with performance tasks, platform-use evidence, or observation of digitally supported teaching.

The source manuscript originally sought to compare faculties, and the descriptive profile suggests that disciplinary context may matter. Prior work has found variation in digital competence across teacher characteristics and professional contexts [20], [22], [32]. However, the present dataset as reported does not permit a defensible test of faculty differences because

the inferential tables and percentages are internally inconsistent. A future multi-faculty study should report faculty-specific sample sizes, use a validated multidimensional instrument such as DigCompEdu, verify assumptions for group comparisons, and apply an inferential procedure appropriate to the actual number of faculties and measurement level.

The findings have direct institutional implications. First, universities should separate basic digital orientation from advanced pedagogical development. Faculty who already use messaging, cloud storage, and productivity tools need training in VLE-supported learning design, authentic digital assessment, interaction and feedback, and inclusive online pedagogy. Second, professional learning should be sustained and practice-based; competence-based pathways and collaborative models can help teachers develop progressively rather than through one-off workshops [5], [6], [25]. Third, infrastructure and support systems need to be treated as components of digital competence ecology, because teachers cannot enact sophisticated pedagogy consistently when connectivity, platform quality, technical support, or time are inadequate. Finally, professional development should recognize that digital transformation can require changes in teachers' conceptions of teaching, not only changes in tools [27], [28].

Limitations and Suggestions

This study has several limitations. It is based on one university and a cross-sectional self-report survey, which limits generalization and does not establish causal relationships. The source manuscript does not report the date of data collection, a validated external instrument name, faculty-specific sample sizes, or ethics-approval metadata. The challenge subscale shows comparatively low internal consistency. In addition, the original faculty percentages and ANOVA tables contained internal inconsistencies; consequently, faculty-level inferential claims were removed. Future studies should use a validated framework such as DigCompEdu, report complete instrument-development procedures, include objective or behavioral indicators of digital competence, apply probability sampling across multiple Pakistani universities, and examine how digital competence relates to teaching quality, student engagement, and sustained use of blended-learning environments.

Conclusion

The post-COVID digital profile of university teachers in Islamabad is not one of simple digital deficiency. Instead, it is characterized by strong routine operational use alongside weaker pedagogical integration and persistent institutional barriers. Teachers reported high competence in communication, file management, cloud-based practices, and common digital assessment activities, but much lower use of virtual learning environments and more advanced information-search practices. At the same time, infrastructure, technology quality, time, costs, online materials,

and feedback were widely perceived as barriers. These findings shift the development priority from basic tool training toward professional digital pedagogy: VLE-based course design, feedback and assessment, information literacy, reflective professional learning, and reliable institutional support. For higher education institutions seeking to retain the constructive gains of pandemic-era digitalization, professional digital competence should be developed as an integrated pedagogical and organizational capacity rather than as a collection of isolated technical skills.

Conflict of Interest

The authors declare no conflict of interest.

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Authors



Misbah Shafait Abbasi   is a PhD student in Comparative Education at Zhejiang Normal University in Jinhua, China. Her academic interests focus on comparative and international education, educational policy, and cross-cultural perspectives in schooling and higher education. Through her doctoral studies, he seeks to deepen understanding of educational systems across contexts and contribute to research that supports effective and equitable educational development globally. (email: misbahshafaitabbasi@gmail.com).



Prof. Dr. Yu Rong   is a professor and doctoral supervisor at Zhejiang Normal University in Jinhua, China. His academic work focuses on education, comparative perspectives, and scholarly research development. Through doctoral supervision, he supports students in strengthening theoretical understanding, research methodology, academic writing, and the development of rigorous comparative education studies. (email: yurong@zjnu.cn).