The Lighthouse Journal of Social Sciences, Vol. 03, Issue 2, Winter 2024, pp. 134-148

Bridging the Digital Divide: Technology Adoption among College Teachers in Khyber Pakhtunkhwa

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ABSTRACT

This study investigates the adoption and integration of online applications in college-level teaching among faculty members in public sector colleges of Khyber Pakhtunkhwa, Pakistan. Utilizing a descriptive survey design, data were collected from 447 Lecturers, Assistant Professors, and Associate Professors across multiple districts. The research explores faculty access to internet and digital tools, their usage patterns, and the extent to which they engage with platforms such as Google Classroom, Zoom, and Microsoft Teams. Findings reveal that while a majority of faculty members have access to internet and personal equipment, actual usage of digital tools remains uneven. The study identifies a moderate level of engagement with online teaching practices, with Zoom being the most widely used platform. However, fewer faculty members have taken initiative in designing digital classrooms or conducting online assessments. The results underscore the need for targeted professional development and institutional support to bridge the digital divide and enhance the effective use of technology in higher education. The study contributes to policy formulation and capacity-building strategies, aimed at fostering digital competence among college educators in the region.

Keywords: *Online applications, Digital Tools, Google Classroom, Zoom, Microsoft Teams, Technology*

INTRODUCTION

The integration of online applications into college-level teaching has become a defining feature of modern education systems. As digital tools continue to evolve, their role in shaping instructional practices, enhancing student engagement, and expanding access to learning opportunities has grown significantly. In the context of public sector colleges in Khyber Pakhtunkhwa, where faculty members range from Lecturers to Professors, the adoption of online teaching technologies presents both opportunities and challenges that warrant systematic investigation.

This study is grounded in a descriptive research design aimed at capturing the current landscape of online application usage among college teachers in the region. Through a structured survey administered to a purposive sample of Lecturers, Assistant professors, Associate

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Manuscript Submitted: December 10, 2024
Manuscript Accepted: December 30, 2024

Professors, and Professors; the research seeks to document their experiences, motivations, and perceived effectiveness of using digital tools in their teaching practices. The focus is not only on the extent of usage but also on the contextual factors—such as institutional support, digital literacy, and infrastructure—that influence the integration of these technologies.

Understanding how faculty members engage with online applications is critical for several reasons. First, it provides empirical insights into the pedagogical shifts occurring within government colleges, especially in the aftermath of the COVID-19 pandemic, which accelerated the move toward digital instruction. Second, it highlights the disparities in access, training, and technological readiness that may hinder effective implementation. Third, and most importantly, it generates actionable data that can inform policy decisions, professional development programs, and resource allocation strategies aimed at improving teaching quality and student outcomes.

While online applications offer flexibility, interactivity, and the potential for personalized learning, their impact is mediated by how well they are understood, adopted, and supported by educators. This study, therefore, contributes to a growing body of knowledge by providing a localized, evidence-based understanding of the digital teaching practices in Khyber Pakhtunkhwa's college sector. The findings are expected to guide future interventions that enhance the meaningful use of technology in higher education across the province.

LITERATURE REVIEW

Modern teachers are expected to use available technology in their teaching assignments. The integration of online applications in college teaching has gained significant attention in recent years due to advancements in technology and the increasing availability of internet resources. This review aims to explore the use of online applications in college teaching, focusing on their benefits, challenges, and impact on student learning outcomes. Online applications provide various multimedia tools, such as videos, interactive simulations, and virtual labs, which can enhance content delivery and engage students in active learning. Research by Clark and Mayer (2016) suggests that incorporating multimedia elements improves learning outcomes and knowledge retention. We need to monitor this in the context of Khyber Pakhtunkhwa where colleges provide students a variety of programs and courses. Students can be engaged in classrooms by the use of such technologies and also the online applications offer opportunities for student interaction and engagement. Features like discussion boards, collaborative projects, and real-time feedback promote active participation and foster a sense of community among students (Bower et al., 2014). This active engagement can lead to higher motivation, improved learning outcomes, and a sense of ownership over the learning process. Online applications provide flexible learning options, allowing students to access course materials and resources at their convenience. This flexibility accommodates diverse learning styles and individual schedules (Simonson et al., 2015). Additionally, online applications enable access to learning materials and interactions for students with disabilities, promoting inclusivity (Rao et al., 2019). Theoretically, it sounds great to train teachers to enhance engagement of students by applications offered by computing technologies, however they remain in question from the context of infrastructure, internet access, and gadgets availability. In addition, there is a need to work on teacher training and skill building of college teachers.

Online applications often include adaptive learning features that tailor content and assessments to individual student needs. By tracking student progress and providing targeted feedback, these applications can address knowledge gaps and support personalized learning experiences (Johnson et al., 2014). Such personalized approaches can enhance student motivation and improve learning outcomes. In spite of multiple benefits there are limitations and challenges that must be considered while reaping benefits is considered. Incorporating online applications in college teaching requires reliable internet connectivity and technical infrastructure. Technical issues, such as system crashes, slow internet speed, or incompatible devices, can hinder the seamless integration of online applications (Hew & Cheung, 2013). Pakistan has been subject to demand-supply gap of electricity in recent times and education budgets have been not enough. The challenges have led to frustration among students and faculty, affecting the overall learning experience. Provision of resources and effective use of online applications necessitates digital literacy skills among both students and faculty. At the same time, college teachers in Khyber Pakhtunkhwa lack adequate training or familiarity with these tools that hinder their implementation and limit their potential benefits which is also supported by theoretical notions given by (Chen et al., 2015). Institutions need to provide professional development opportunities and support to enhance digital literacy skills among faculty members. Simply using online applications does not guarantee improved learning outcomes.

College teaching in Khyber Pakhtunkhwa need to pave way for better alignment between teaching and learning enhancement. Effective integration requires careful alignment between pedagogical strategies, learning objectives, and the features of the online applications used (Margaryan et al., 2015). Instructors must critically evaluate the suitability of online applications for specific learning tasks and ensure they align with desired learning outcomes. The use of online applications can exacerbate existing inequities in access to technology and reliable internet connections (Czerniewicz et al., 2020). Students from disadvantaged backgrounds or under-resourced areas may face barriers to accessing online resources, limiting their participation and learning opportunities. This may be very true in the context of Khyber Pakhtunkhwa as urban or sub-urban or even colleges in rural setups have a high frequency of students who come from disadvantaged backgrounds. There are several studies that support computing applications serving the purpose of college teaching. Research indicates that the use of online applications in college teaching has a positive impact on student learning outcomes. A meta-analysis by Means et al. (2013) found that online learning, including the use of applications, is as effective as face-to-face instruction, and in some cases, leads to better outcomes. The study suggests that well-designed online applications, combined with appropriate instructional strategies, can enhance student learning. However, it is important to note that the effectiveness of online applications depends on various factors, including pedagogical approaches, student characteristics, and the nature of the learning tasks.

In the wake of the COVID-19 pandemic, use of applications in college teaching has become increasingly important in Pakistan, especially, this necessitated a rapid shift to online and remote learning. Online applications have the potential to address issues of access to education in Pakistan. They can reach students in remote areas or those who face barriers to attending traditional brick-and-mortar institutions (Raza et al., 2021). Online applications enable students to access educational resources and participate in virtual classrooms, expanding educational

opportunities across the country. The use of online applications allows for flexible learning options, accommodating the diverse needs and schedules of students. Asynchronous learning through recorded lectures, discussion forums, and online assignments enables students to engage with course materials at their own pace (Abbas et al., 2020). This flexibility is particularly beneficial for non-traditional students or those juggling work and family commitments. Online applications provide interactive features such as virtual labs, multimedia content, and gamified activities, fostering active learning and student engagement (Siddique et al., 2021). These features can enhance students' understanding, motivation, and critical thinking skills.

There are several benefits of the use of this technology as online applications facilitate collaboration among students through discussion boards, group projects, and shared documents. This collaborative environment encourages peer interaction, knowledge sharing, and the development of teamwork skills (Hussain et al., 2020). Collaborative learning is particularly valuable in Pashtun culture, where communal and social learning practices are highly valued. The benefits may be many but Pakistan faces a significant digital divide, with limited internet access, uneven technological infrastructure, and disparities in device ownership among students (Saeed et al., 2020). This divide poses challenges to the widespread adoption of online applications, particularly for students from disadvantaged backgrounds or rural areas. Insufficient technological infrastructure, including unreliable internet connectivity, frequent power outages, and limited access to devices, hinders the effective use of online applications in college teaching (Khan et al., 2021). Teachers and students often face technical difficulties that disrupt the learning process and reduce the effectiveness of online applications. The successful integration of online applications requires a shift in pedagogical approaches and instructional strategies. Faculty members may need support and training to adapt their teaching methods for online environments, including the design of effective online assessments and the promotion of active learning (Hameed et al., 2020).

Ensuring the quality and integrity of assessments in online environments can be challenging. Plagiarism and cheating are potential concerns in remote learning settings, requiring the implementation of appropriate measures and robust assessment strategies (Khattak et al., 2021). Several studies have explored the impact of online applications on student learning outcomes in college teaching in Khyber Pakhtunkhwa. Chandio R.A (2020) found that perceived ease of use, perceived usefulness, social influence, perceived quality, and intention to use e-learning are significantly related to use of technology in teaching in Pakistan. Another study by Ali et al. (2021) revealed that students perceived online applications as beneficial for their learning, promoting critical thinking and independent learning skills. However, it is crucial to note that the effectiveness of online applications in college teaching in Pakistan depends on several factors, including the quality of content, pedagogical approaches, technical support, and students' digital literacy skills.

College teachers play a crucial role in shaping the educational experiences and outcomes of students. The abilities and competencies of college teachers are essential factors in ensuring quality education. Pedagogical competence refers to the ability of college teachers to effectively deliver instruction, facilitate learning, and engage students in the learning process. Research suggests that pedagogical competence is vital for effective teaching (Mahmood & Mahmood, 2020). College teachers in Khyber Pakhtunkhwa need to possess a solid understanding of teaching

methodologies, instructional strategies, and assessment practices to create a conducive learning environment. Subject matter expertise is a fundamental ability of college teachers as it enables them to impart accurate and up-to-date knowledge to students. College teachers are expected to possess in-depth knowledge of their respective disciplines to effectively teach and guide students (Khan & Ali, 2019).

Continuous professional development and staying updated with the latest research and developments in their fields are crucial for maintaining subject matter expertise. Effective communication and presentation skills are essential for college teachers to convey information clearly and engage students in the learning process. In Pakistan, college teachers need to be proficient in both English and Urdu, the primary languages of instruction (Ashraf et al., 2019). Strong communication skills, including clarity, coherence, and the ability to adapt to diverse student backgrounds, are crucial for effective teaching. Classroom management skills are essential for creating a positive and productive learning environment. College teachers in Pakistan should be able to establish and maintain discipline, manage student behavior, and create an inclusive and respectful classroom atmosphere (Haider & Khan, 2020). Effective classroom management allows for optimal student engagement and contributes to a conducive learning environment.

With the increasing integration of technology in education, college teachers in Khyber Pakhtunkhwa need to possess technological competence. This includes familiarity with online learning platforms, multimedia tools, and digital resources to enhance teaching and learning experiences (Hussain et al., 2021). Technological competence enables teachers to effectively utilize digital tools for content delivery, student engagement, and assessment. This approach focuses on the individual needs, interests, and abilities of students, promoting active learning, critical thinking, and problem-solving skills (Hussain et al., 2021). College teachers need to create opportunities for student engagement, encourage collaborative learning, and provide timely feedback to support student development and success. Engaging in continuous professional development is essential for college teachers in Khyber Pakhtunkhwa to enhance their abilities. Professional development opportunities, such as workshops, seminars, conferences, and research activities, enable teachers to update their knowledge, learn new teaching strategies, and stay abreast of advancements in their respective fields (Zia et al., 2021). Continuous professional development contributes to the growth and improvement of college teachers' abilities over time.

The abilities of college teachers in Khyber Pakhtunkhwa are critical for providing quality education and fostering student success. Pedagogical competence, subject matter expertise, communication skills, classroom management, technological competence, student-centered approach, and continuous professional development are key areas that contribute to the effectiveness of college teachers. Strengthening these abilities through training, support, and professional development opportunities can enhance the overall quality of teaching and learning in local colleges. Considering numerous benefits of using online applications can significantly contribute to the improved student learning outcomes and better preparation for the evolving demands of the modern world. This suggests that college level teaching in Khyber Pakhtunkhwa has to embrace the interventions of most modern technologies in teaching. Education departments with the help of training and research institutions have to consider ways that can increase capacity and make education more meaningful, relevant, and accessible for students in the country.

RESEARCH METHODOLOGY

The objective of this study is to describe the use of online applications in college-level teaching and explore the perspectives of college teachers regarding their usage, background, and motivation. This research has employed a survey method to collect data from college teachers who are working in the Government of Khyber Pakhtunkhwa.

Population Structure & Sample

According to the report titled 'Khyber Pakhtunkhwa in figures 2021' published online by Bureau of Statistics of Government of Khyber Pakhtunkhwa there are 428 colleges including postgraduate colleges offering degrees in different disciplines. This total excludes polytechnic, technical, and vocational colleges. The target population of teaching staff from these 428 colleges is 9162. The Directorate of Higher Education, Khyber Pakhtunkhwa established Khyber Pakhtunkhwa Higher Education Academy of Research and Training (HEART) in 2013 that is mainly responsible for training and building capacity of college staff in the province by offering mandatory trainings required for promotions to the next cadre. HEART holds 30-days training for faculty members and staff on topics of academic and administrative interest and it has been offering online trainings and also has conducted some trainings on the use of technology in college teaching.

A purposive sampling technique is used to select participants for the survey. Purposive sampling is deemed appropriate in this descriptive research as it allows the study to select participants who are currently working in government colleges of Khyber Pakhtunkhwa and also have specific knowledge or experience of using or not using the relevant applications/tools/online provisions relevant to the study. This enhances the depth and relevance of the data collected. It also ensures efficient use of resources by focusing on information-rich cases. College teachers who participate in trainings arranged by HEART are the target population. The sample size is determined based on the feasibility of data collection and the desired level of statistical confidence. The survey included random batches of trainees attending the on-campus training of HEART and totaled a sample of 436 college teachers, which by any statistical means is regarded a representative sample for a survey research. These 436 college lecturers/teachers were given a survey (annexed with this paper) which was also designed on Google forms. Respondents were requested to provide personal and job related information including their knowledge and use of modern applications in their college teaching.

Survey Instrument Design

A structured questionnaire was developed as the survey instrument having a few open-ended questions. Since the questionnaire consisted of both closed-ended and open-ended questions to capture quantitative and qualitative data. The questions were mainly designed to assess the use of online apps/platforms in terms of usage, challenge, and motivation. Questions covered various

aspects related to the use of online applications, including frequency of usage, types of applications used, perceived benefits, challenges encountered, and impact on student learning outcomes.

The questionnaire was developed based on a review of existing literature on the use of online applications in college-level teaching. It was designed to ensure clarity, relevance, and comprehensiveness of the data collected. The questionnaire was piloted with a small group of college teachers at the design stage and was modified to assure reliability. Cronbach's alpha was found well-above the acceptable ranges of 0.7. Validity of the instrument was assured through content, construct, and criterion related features.

The survey was administered electronically, utilizing online survey platform by sharing a Google classroom link to help participants access the questionnaire. Participants were provided with clear instructions on how to complete the survey. To enhance the response rate, reminders were sent to a few respondents. Data collection was conducted over a long period of several months to ensure gathering information from more respondents purposively. Since most of the data that emerged was categorical in nature, several data presentations were used including tables, graphs, diagrams to have a clear description of important questions in terms of usage of online applications, its motivation, experience etc.

Ethical considerations were taken into account throughout the research process. Informed consent was obtained from participants, ensuring confidentiality and anonymity of their responses. The research complied with relevant ethical guidelines and regulations to protect the rights and well-being of the participants. This study like any other research study is not free from limitations. Firstly, the survey responses are based on self-reporting, which may be subject to biases or inaccuracies. Secondly, the sample may not represent the entire population of college teachers, as it relies on a purposive sampling technique. Lastly, the study's findings may be influenced by the context and specific characteristics of the surveyed institutions.

DATA ANALYSIS AND DISCUSSIONS

The sampled survey data comprised of 436 responses which was analyzed in the context of information needed. The following information exhibits main findings from the gathered data in the context of research objectives.

Table-1: shows the sample of college teachers who are included in the survey position-wise.

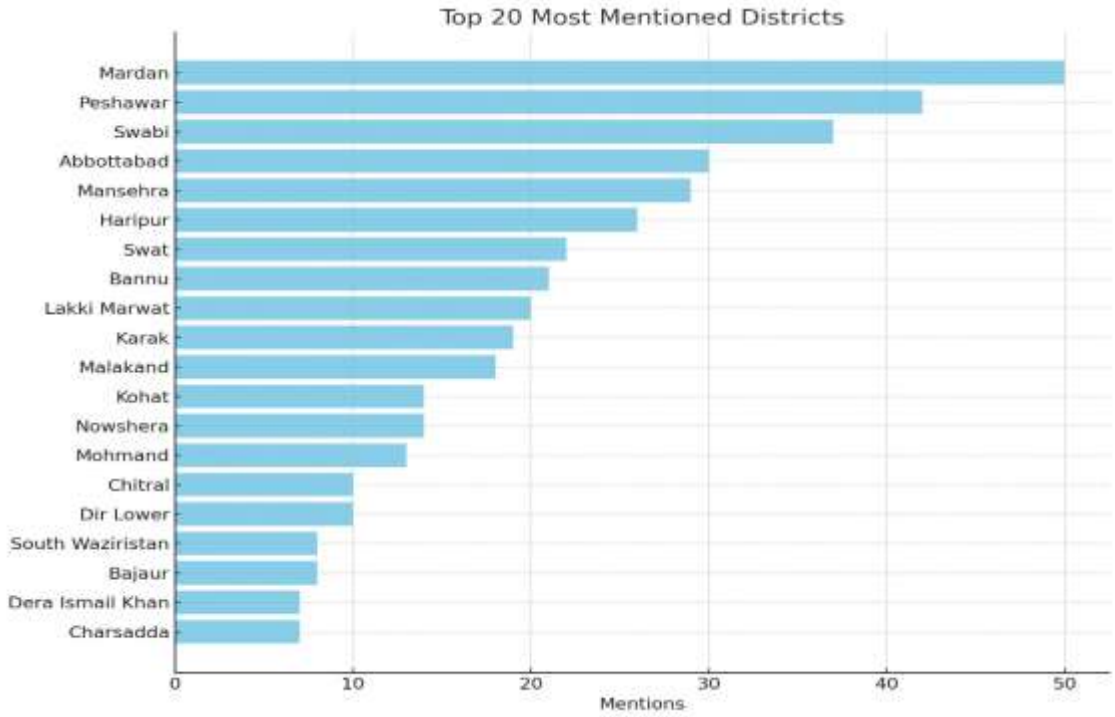
Table-1: Survey respondents by Gender and Academic Rank

		Position/Rank			
		Lecturer	Assistant Professor	Associate Professor	Total
G	Male	6	229	71	306
	Female	3	102	35	140

Total	9	331	106	446

The research survey is filled by college teachers of several districts of Khyber Pakhtunkhwa. Figure-1 shows the top 20 mentions of the districts who submitted the survey and provided research information.

Figure-1: Top 20 Districts Covered

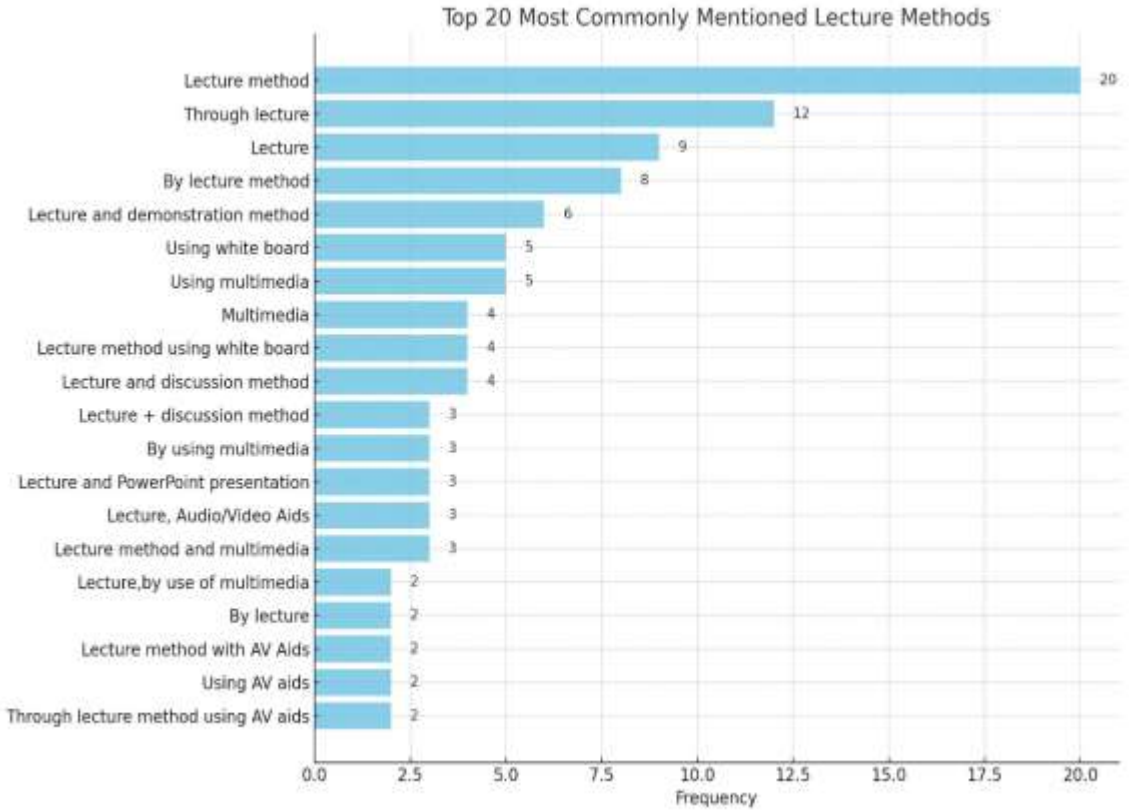


The survey respondents are all college lecturers, assistant professors, or associate professors who teach the intermediate level typically the Grade-11 or 12 programs titled as Faculty of Arts (F.A.) and Faculty of Science (F.Sc.) which are equivalent to High School Education in many education systems. After the introduction of BS (Hon's) programs in colleges, the college teachers now teach the variety of these program. These programs stretch from humanities to social sciences to pure sciences. Since there a great diversity in the offerings of these programs, it demands ample preparation in the use of technology in planning and executing of courses and programs.

This survey is designed to produce descriptive evidence in terms of awareness of college teachers as to what extent and advantage are they using the past faced changing internet and application technology in their teaching. Are they using the most common platforms like Google or Microsoft in planning their courses, implementing them by conducting online meetings or surveys or if they are using artificial intelligence (AI) chatbots or models aimed towards learning enhancement of the students. Advanced learning management systems are making strides every single day as they are providing a platform where a teacher can work to the full capacity by relying on specialized tools available.

Figure-2 mentions the top 20 methods of lecturing students in classroom that shows 102 survey responses in terms of their actual response to the question 'How do you teach your most favorite course?'

Figure-2: Most mentioned Methods



An important question in this debate is the college teachers' access to internet; the following information is gathered in terms of gender; Table-2 shows 54% have access to uninterrupted internet whereas 46% of the respondents are not having access to internet. Surprisingly, female college teachers seem to have more access compared to their male counterparts.

Table-2: Access to Internet by Gender

		Access to Internet		
		No	Yes	Total
G	Male	142	164	306
	Female	63	78	140
Total		205	242	447

Another important dimension of the debate is that whether college teachers have access to technology, possess the needed equipment and have a genuine desire to include computing technologies including software and hardware in their teaching. Table-3 shows important statistics in this regard.

Table-3: Use of Equipment and Technology

		Position/Rank		
		Lecturer	Assistant Professor	Associate Professor
Access to Internet	No	7	154	44
	Yes	2	177	63
Personal Equipment	No	0	4	2
	Yes	9	327	105
Usage of Equipment	No	0	65	27
	Yes	9	266	80
Online course taught	No	5	141	59
	Yes	4	190	48
Use of G-Suite or Google Apps	No	6	198	66
	Yes	3	133	41
Use of Microsoft Teams	No	6	216	79
	Yes	3	113	28
Use of Zoom Cloud Services	No	4	131	51
	Yes	5	200	56
Google Classroom Design	No	6	235	80
	Yes	3	96	27
Initiated meetings on Google/Zoom/Microsoft	No	6	201	73
	Yes	3	130	34
Worked on Google Classroom	No	7	215	70
	Yes	2	116	37

Designed and/or conducted online survey/exam	No	9	236	86
	Yes	0	95	21

This survey conducted among 447 college faculty members across Khyber Pakhtunkhwa reveals a nuanced picture of digital readiness and pedagogical adaptation in public sector higher education. The data suggests that while access to internet and personal equipment is relatively widespread, especially among Assistant and Associate Professors, disparities remain in terms of actual usage and digital engagement. A significant majority of respondents report having access to the internet and owning personal digital equipment, indicating that infrastructural barriers are not the primary constraint. The gaps between access and utilization points to a potential need for targeted training and institutional support.

The adoption of online teaching practices, such as delivering courses virtually, is moderately high, with over half of the respondents having taught online. This reflects a shift in pedagogical practices, likely accelerated by the COVID-19 pandemic. However, the use of specific platforms like Google Apps, Microsoft Teams, and Zoom varies, with Zoom emerging as the most commonly used tool. This preference may be attributed to its user-friendly interface and widespread familiarity. Furthermore, while a considerable number of faculty members have participated in online meetings, fewer have taken the initiative to organize them. This indicates a reactive rather than proactive approach to digital engagement. Similarly, although many have worked within Google Classroom environments, fewer have designed these spaces themselves, implying reliance on pre-existing structures or support from more digitally literate colleagues. The ability to design and conduct online assessments, such as surveys and exams, is present in a smaller subset of the faculty, highlighting a critical area for capacity building.

These findings underscore a transitional phase in the digital evolution of college teaching in Khyber Pakhtunkhwa. While foundational infrastructure is largely in place, the effective and innovative use of digital tools remains uneven. Using the core 11 questions from Table-3 that exclude the first two questions i.e. access to internet and personal equipment an additive scale is designed using the remaining 9 questions. Since every question is binary generating a response of 0 and 1 where 0 means No and Yes means1. A variable titled ‘Usage’ is developed which ranges from 0 to 8 where 0 means no usage and 8 means the most significant usage. On this scale every college teacher is measured to have used technology in teaching. This gives us Table-4 that shows the frequency and distribution of technology usage in college teaching. The distribution can be seen using Figure-3.

Figure-3: Distribution of Usage of Technology

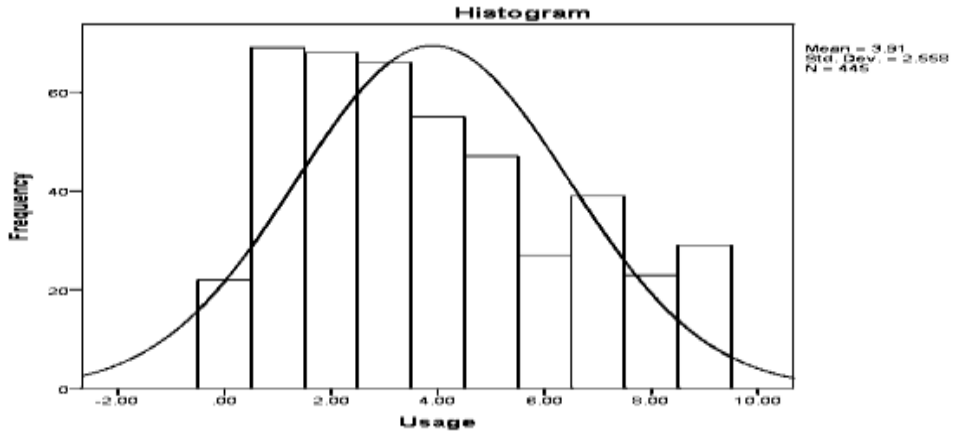


Table-4 shows that 62.9% of surveyed teachers are using below the average number of technology interventions used as a survey standard. This is visible from the skewed nature of the curve in Figure-3 showing that few college teachers are using technology in their college teaching.

Table-4: Usage of Technology in College Teaching

Scale Measurement		Frequency	Percent	Cumulative Percent
Valid	.00	22	4.9	4.9
	1.00	69	15.4	20.4
	2.00	68	15.2	35.7
	3.00	66	14.8	50.6
	4.00	55	12.3	62.9
	5.00	47	10.5	73.5
	6.00	27	6.0	79.6
	7.00	39	8.7	88.3
	8.00	23	5.1	93.5
	9.00	29	6.5	100.0
	Total	445	99.6	

Table-5 reflects on further important aspects of the distribution of usage of technology. The averages differ confirming abnormality particularly slight positive skewness in usage with the most popular usage scale of 1 mentioning only one of the nine most popular ways of usage. Table-

5 also shows the percentile breakup of the distribution in terms of technology usage by college teachers.

Table-5: Usage of Technology

Mean		3.9056
Median		3.0000
Mode		1.00
Std. Deviation		2.55834
Skewness		.453
Kurtosis		-.828
Minimum		.00
Maximum		9.00
Percentiles	25	2.0000
	50	3.0000
	75	6.0000

CONCLUSION

The findings of this study highlight a transitional phase in the digital transformation of college teaching in Khyber Pakhtunkhwa. While foundational infrastructure such as internet access and personal equipment is largely in place, the effective and innovative use of digital tools remains inconsistent across faculty ranks. Assistant and Associate Professors demonstrate higher levels of engagement with online teaching platforms compared to Lecturers, suggesting disparities in digital readiness and training. The widespread use of Zoom indicates a preference for user-friendly tools, yet the underutilization of more structured platforms like Google Classroom and Microsoft Teams points to a gap in digital pedagogical practices. Furthermore, the limited initiative in designing online classrooms and assessments reflects a reactive rather than proactive approach to technology integration. These insights call for strategic interventions in faculty development, focusing on digital literacy, pedagogical innovation, and curriculum integration. Strengthening these areas will not only improve teaching effectiveness but also ensure equitable and meaningful learning experiences for students across the province. As education systems continue to evolve, bridging the digital divide remains essential for fostering inclusive and future-ready higher education in Pakistan.

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