Research Article

Exploring the Application and Challenges of Digital Resources for Self-Study in Basic Sciences among Medical Students.

Muhammad Shahzaib[1], Muhammad Tayyab[2], Muhammad Usama[3], Ramsha Mushtaq Khan[4], Muhammad Sohaib[5], Sandal Tariq[6]

[1-6] *King Edward Medical University, Lahore/Mayo Hospital Lahore.*

Abstract

Background: In the rapidly evolving landscape of medical education, digital resources have transformed how students engage with fundamental concepts in basic sciences, offering new avenues for self-directed learning. Recent studies indicate that over 85% of medical students rely on electronic sources as their primary means of learning, surpassing traditional paper-based materials. As digital technologies continue to advance, their integration into medical education has become more prevalent and increasingly essential. However, this shift calls for the need to identify and address the unique challenges associated with the effective use of digital resources for self-study in medical students.

Objectives: This study investigates the effectiveness and challenges associated with utilizing digital tools for self-directed learning among medical students.

Methods: A cross-sectional survey was conducted among first and second-year medical students at a public sector medical university in Lahore, Pakistan, from February to September 2024 using a validated online questionnaire. Non-probability convenient sampling was employed to collect data from 96 students, analyzed using SPSS.

Results: Most students (59.4%) strongly agreed on the necessity of digital resources. YouTube emerged as the most useful resource (93.8%, 95% CI [88.9%, 98.6%], $Z = 15.556$, $p < 0.001$), with 59.4% of students studying 3-10 hours weekly. The textbook-first learning approach was significantly more prevalent (79.2%, 95% CI [71.0%, 87.3%], $Z = 9.620$, $p < 0.001$). Challenges included resource affordability (39.6%) and accessibility. Despite challenges, 70.8% of students reported significant benefits from digital resources.

Conclusion: The study highlights the growing importance of digital resources in medical education, emphasizing the need for affordable, accessible, and integrated digital learning tools.

Keywords: Digital, Self-Study, Medical Students, Challenges

Corresponding Authors: Ramsha Mushtaq Khan **Email:** ramsha.mushtaq.khan@kemu.edu.pk

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Introduction

The landscape of medical education is undergoing a significant transformation, with digital resources reshaping the interaction between students and foundational concepts in basic sciences. These technological innovations have provided medical students with a vast array of online resources, offering access to a wide array of online resources such as e-books, video lectures, anatomy atlases, and virtual laboratories.[1,2] Integrating these digital tools has expanded the scope of self-directed learning and introduced new opportunities for personalized education tailored to individual learning preferences.[3] For instance, interactive multimedia components, such as 3D anatomical models and gamified learning platforms, have been shown to enhance comprehension, retention, and application of complex scientific concepts, particularly benefiting visual and kinesthetic learners.[4,5]

Despite these advantages, the adoption of digital resources in medical education is accompanied by significant challenges. Technological disparities, including limited internet connectivity and unequal access to devices, remain persistent barriers, particularly in low-resource settings.[6] The absence of stringent quality control measures makes it difficult for students to discern accurate information from unreliable sources, as students often struggle to evaluate the credibility and accuracy of information.[7] This issue highlights the need for enhanced digital literacy skills among students and faculty alike. The lack of standardized frameworks for integrating digital tools into curricula has resulted in inconsistent implementation, limiting their potential impact on learning

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outcomes.[8] Recent studies highlight the importance of faculty development programs to equip educators with the skills necessary to effectively incorporate technology into teaching practices.[9]

The shift toward digital learning necessitates a reevaluation of traditional pedagogical approaches. Self-directed learning, while empowering, requires students to develop critical appraisal skills to navigate vast amounts of online information and discern high-quality educational content from unreliable sources.[10] This transition also raises questions about the role of Learning Management Systems (LMS) in cultivating structured yet flexible learning environments. While LMS platforms offer significant potential for enhancing accessibility and engagement, their effectiveness is often hindered by technical issues, inadequate training, and resistance to change among stakeholders.[11]

This study aims to investigate the effectiveness and limitations of digital resources in facilitating self-directed learning among medical students in basic sciences. By exploring current usage patterns, identifying common challenges, and evaluating student perceptions, this research seeks to provide actionable insights into optimizing the integration of digital tools in medical education. The research aspires to inform strategies to improve educational outcomes and, by extension, patient care, aligning with the broader goals of modernizing medical education in an increasingly digital era.[12]

Mathods

A cross-sectional study was conducted from February to September 2024 at a public sector medical university in Lahore, Pakistan. The sample size (n=96) was determined using the WHO sample size calculator, with a 95% confidence interval and 5% margin of error, accounting for the expected prevalence of 50%.[13] Non-probability convenience sampling was employed, targeting first- and second-year MBBS students. Exclusion criteria included students from third, fourth, and final years, as well as those enrolled in BDS, Allied Health Sciences (AHS), and postgraduate programs.

Data were collected using an online questionnaire adapted from the reference study. The questionnaire assessed demographics, preferred digital resources, study habits, subjects for which digital resources were utilized, reasons for using or not using digital resources, challenges faced, and perceptions of the necessity and benefits of digital resources. The study was approved by the relevant Institutional Review Board. Written informed consent was obtained from all participants before data collection. Data analysis was performed using SPSS version 27, employing descriptive statistics including frequencies, percentages, and chi-square tests for categorical variables.

Results

The study comprised 96 medical students, with males representing 55.2% (n=53) and females 44.8% (n=43) of the sample. The distribution between academic years is represented in Table 1.

YouTube emerged as the significantly preferred digital resource (93.8%, 95% CI [88.9%, 98.6%], $Z = 15.556$, $p < 0.001$) (Figure 1). Regarding subject preferences, Anatomy/Histology was the most popular for digital resource use (80.2%, n=77), followed by Biochemistry (10.4%, n=10) and Physiology (9.4%, n=9). The majority of students (59.4%, n=57) reported dedicating 3-10 hours weekly to self-study using digital resources. Smaller

Table 1: *Demographic Characteristics of Participants*

Characteristic	Frequency (n)	Percentage (%)
Gender		
- Male	53	55.2
- Female	43	44.8
Year of Study		
- First Year	41	42.7
- Second Year	55	57.3

Smaller proportions spent less than 3 hours (16.7%, n=16), 10-20 hours (15.6%, n=15), or more than 20 hours (8.3%, n=8) per week.

Most students (79.2%, n=76) followed a traditional approach, consulting textbooks before utilizing digital resources. A smaller segment (15.6%, n=15) primarily relied on digital resources without textbook reference, while 5.2% (n=5) used digital resources only under time constraints. The primary motivations for digital resource usage included ease of understanding (52.1%, n=50) and visual learning preferences (39.6%, n=38). Equal proportions (4.2%, n=4 each) cited textbook insufficiency and accessibility as reasons for adoption.

The most significant barrier to digital resource utilization was the cost of paid resources (39.6%, n=38). Equal proportions of students reported accessibility issues and

language barriers (6.3%, n=6 each) (Table 2). A strong majority of students (92.7%, n=89) agreed or strongly agreed that digital resources are necessary in contemporary medical education. Most students (70.8%, n=68) reported substantial benefits from digital resources, with 19.8% (n=19) indicating moderate benefits and 9.4% (n=9) finding them beneficial only as supplements to traditional textbooks (Table 3).

Table 2: *Challenges in Using Digital Resources*

Challenge	Number of Respondents (n)	Percentage (%)
Not Easily Accessible	6	6.3
Some Paid Resources Are Unaffordable as a Student	38	39.6
Language Barrier with the International Tutor/Resource	6	6.3
I Have Never Faced Challenges in Using Digital Resources So Far	46	47.9

The likelihood of recommending digital resources to peers was high, with 94.8% (n=91) of students likely or very likely to recommend their use. Only a small fraction. (4.2%, n=4) expressed reluctance to recommend digital resources, while 1.0% (n=1) remained neutral.

Table 3: *Perception of Digital Resources as a Necessity*

Perception of Necessity	Number of Students (%)
Strongly agree	57 (59.4%)
Agree	32 (33.3%)
Neutral	5 (5.2%)
Disagree	1 (1.0%)
Strongly disagree	1 (1.0%)

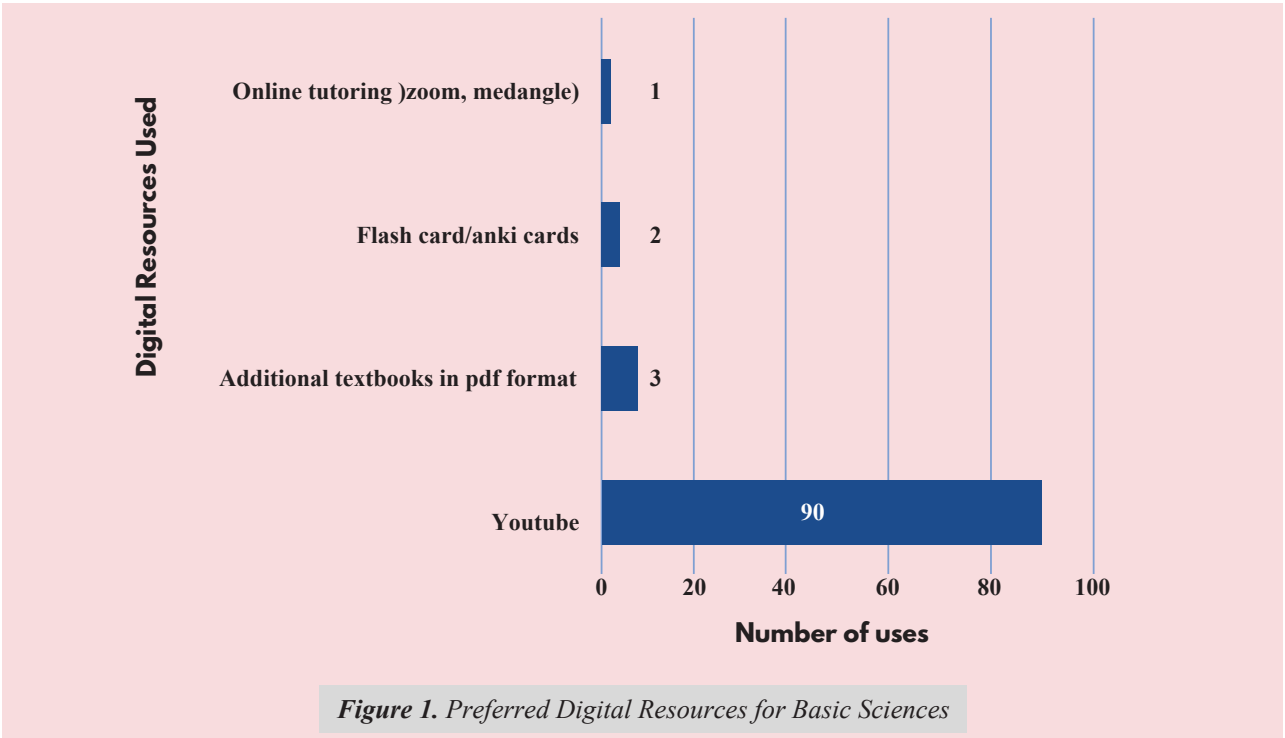

Figure 1. *Preferred Digital Resources for Basic Sciences*

Discussion

The present study reveals several significant patterns in digital resource utilization among medical students, with implications for educational technology integration in medical education. The findings demonstrate a marked preference for digital learning tools, particularly video-based platforms, while simultaneously highlighting persistent barriers to their optimal implementation.

The predominant use of YouTube (93.8%) as an educational platform aligns with contemporary research on multimedia learning effectiveness. This preference reflects the platform's capacity to deliver multimodal content that accommodates diverse learning styles, particularly beneficial for understanding complex spatial relationships in subjects such as anatomy.[14,15] The substantial time investment in self-directed digital learning (59.4% dedicating 3-10 hours weekly) further underscores the integral role of digital resources in modern medical education, particularly in challenging foundational subjects like anatomy and biochemistry.[16]

However, this digital integration presents a nuanced landscape of adoption patterns. The high percentage (79.2%) of students who prioritize textbook consultation before accessing digital resources suggests a complex relationship with traditional learning methods. This finding warrants careful interpretation within the context of recent literature indicating potential barriers to full digital adoption, including content reliability concerns and institutional factors.[17,18] The minimal proportion (6%) of students exclusively utilizing digital resources further emphasizes the persistence of traditional learning methodologies, potentially reflecting institutional hesitancy in fully embracing technology-enhanced learning strategies.[19]

Accessibility emerges as a critical concern, with financial constraints affecting 39.6% of participants. This finding resonates with broader discussions of the "digital divide" in medical education, highlighting socioeconomic disparities in access to premium educational resources.[20] While 47.9% of respondents reported no significant barriers to digital resource utilization, the substantial proportion facing affordability challenges necessitates institutional intervention. Current research advocates for structured solutions, including institutional subscriptions and open-access repositories, to promote equitable access to digital learning tools.[21,22]

The underutilization of collaborative digital platforms presents another area for development, particularly given recent evidence supporting their role in enhancing learning outcomes. Despite the documented benefits of virtual labs and discussion forums, organizational adoption rates remain low.[23,24] This gap between potential and implementation suggests opportunities for expanding the integration of collaborative technologies in medical education. The strong endorsement of digital resources by most respondents (72.9%) indicates their perceived value in medical education. However, the small proportion (2.1%) expressing reluctance to recommend these tools merits attention. This resistance may stem from various factors, including user interface challenges or content quality concerns.[25] Understanding these limitations is crucial for improving digital resource development and implementation.

The present study's limitations warrant consideration when interpreting its findings. The use of non-probability convenient sampling may introduce selection bias, potentially affecting the representativeness of the results. The reliance on self-reported data introduces possible recall and reporting biases. The geographical limitation to medical colleges in Lahore may restrict the generalizability of findings to other contexts.

Future research should focus on key areas to enhance digital resource utilization in medical education: conducting longitudinal studies to track adoption patterns and assess the impact on learning outcomes, systematically evaluating interventions aimed at overcoming existing barriers, investigating faculty perspectives and institutional factors that affect the integration of digital resources, and performing comparative analyses of various digital learning platforms to determine their effectiveness in specific medical subjects. Such comprehensive efforts will provide valuable insights and drive the development of more effective, accessible, and inclusive digital learning environments for medical students.

Conclusion

Digital resources are increasingly crucial in medical education, offering diverse learning opportunities. However, challenges related to affordability and accessibility must be addressed. Future educational strategies should focus on developing integrated, affordable digital learning tools that complement traditional teaching methods.

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Authors Contribution:
RMK, MS: Contributed to the conceptualization and design of the study.
MS, MT, MU, MS, and ST: Responsible for data collection and analysis.
RMK, MS, MT, MU, MS, and ST: Contributed to drafting the manuscript and critically revising it for important intellectual content.
LA: Manuscript Writing
RMK: Manuscript Preparation, Statistical Analysis, Plagiarism Correction.

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