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THE IMPACT OF ICT-BASED RESOURCES ON STUDENT LEARNING OUTCOMES

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Abstract
The rapid integration of Information and Communication Technologies (ICTs) in higher education has transformed the way students' access, retrieve, and utilize information for academic purposes. This study examines the ICT-based information retrieval patterns of undergraduate students in public sector universities in Peshawar, focusing on ICT usage frequency, access points, purpose of use, and its impact on learning outcomes. A quantitative survey method was employed, targeting final-semester undergraduate students, with 290 valid responses analyzed.
Findings reveal that 62.06% of students use ICT resources daily, with mobile phones (72.41%) serving as the primary access point, indicating a shift towards mobile learning and digital accessibility. The primary purposes for ICT usage include online searching (Mean = 4.32) and exam preparation (Mean = 3.92), while research-related activities remain less frequent (Mean = 3.72). Students reported a strong positive impact of ICT on learning (Mean = 4.58) and academic performance, including improved CGPA (Mean = 3.98). However, the preference for ICT over printed materials was moderate (Mean = 3.17), highlighting the continued relevance of traditional learning resources.
Despite these benefits, several barriers hinder effective ICT adoption, including unstable power supply (Mean = 4.56), lack of information retrieval skills (Mean = 4.41), and limited ICT literacy (Mean = 3.22). To enhance ICT effectiveness, universities must implement structured ICT literacy programs, improve digital infrastructure, and promote a blended learning approach. This study underscores the critical role of ICT in modern education and highlights the need for institutional investments in technology and training to maximize student learning outcomes.

INTRODUCTION

Information and Communication Technology has become a cornerstone in modern education, profoundly transforming how knowledge is disseminated, acquired, and utilized (D.Sakthivel, 2021). The evolution of ICT in education can be traced back to the 20th century, with the advent of computers and the internet gradually making their way into classrooms and educational institutions (Pandey & Madhusudhan, 2024). Initially, ICT was employed in education primarily through basic tools like computers and projectors, but as technology progressed, more sophisticated resources, such as

online learning platforms, digital libraries, and multimedia content, began to emerge (Al-Daihani, 2011). The role of ICT in education has since evolved from being a supplementary tool to a central element of the teaching-learning process, with both students and educators relying heavily on digital resources to enhance learning experiences (Shobande & Asongu, 2022).

ICT in education has played a crucial role in breaking down traditional barriers to learning, such as geography and limited access to educational materials. In the last two decades, online learning environments, virtual classrooms, and Massive Open Online Courses have revolutionized access to education, enabling learners from diverse backgrounds to acquire knowledge and skills (Zafar et al., 2022). Furthermore, ICT has fostered collaborative learning through tools like video conferencing, social media, and cloud computing, enabling students to engage in real-time communication and knowledge-sharing beyond physical classrooms (Nungu et al., 2023).

In Pakistan, ICT adoption in education has been somewhat slower but is gaining momentum (Khan et al., 2022). The Pakistani government, through initiatives such as the National ICT Strategy, has recognized the potential of ICT to transform the educational landscape (Ahmad & Sheikh, 2021). While urban areas have seen more rapid integration of ICT tools in schools and universities, rural regions still face significant challenges in terms of infrastructure, internet access, and ICT training for both educators and students. Despite these challenges, the increasing importance of ICT in education is undeniable (Nazir & Khan, 2022).

Pakistani universities are gradually incorporating digital resources like e-journals, online databases, and e-books into their curriculum, allowing students to access information more efficiently (Chandio, 2021). Moreover, ICT is leveraged to improve the quality of education by enhancing teacher training, enabling distance learning, and promoting interactive teaching methodologies (Rafeeq & Ali, 2021).

The growing importance of ICT in education, both globally and within Pakistan, reflects its transformative potential in making learning more engaging, accessible, and inclusive (Alkandari et al., 2024). However, this shift also brings with it the need for policy interventions, adequate infrastructure development, and digital literacy initiatives to fully harness the benefits of ICT in the academic domain (Shehzadi et al., 2020).

The integration of Information and Communication Technology (ICT) in education has become a global priority, with countries investing heavily in digital infrastructure, e-learning platforms, and policy frameworks to enhance learning outcomes. In developed nations, ICT has evolved beyond simple digital literacy to include Artificial Intelligence (AI)-based learning, adaptive educational technologies, and blended learning environments that combine face-to-face teaching with online resources. Governments and educational institutions are leveraging cloud computing, big data analytics, and Learning Management Systems (LMS) to create personalized learning experiences for students. For instance, countries such as Finland, Singapore, and South Korea have incorporated ICT-based curricula that emphasize computational thinking, coding, and digital problem-solving skills, preparing students for the demands of a knowledge-based economy.

A key global trend in ICT integration is the shift toward online and blended learning models, especially in the post-pandemic era. The COVID-19 crisis accelerated the adoption of remote education technologies (Yang, 2022). According to UNESCO, over 1.6 billion students worldwide were affected by school closures, prompting governments to rapidly expand their digital learning strategies (UNESCO, 2023).

In contrast, developing countries are still in the early phases of widespread ICT adoption in education (Niebel, 2017). While the Digital Pakistan Policy emphasize the role of technology in transforming education, challenges such as inadequate infrastructure, low digital literacy, and economic constraints hinder progress (Jamil, 2021). However, the global push for ICT integration is gradually influencing developing nations, with initiatives promoting the use of digital tools in academia (Shair et al., 2022). Pakistan has also witnessed an increase in the adoption of online learning platforms, particularly after the pandemic, with universities incorporating LMS systems and video conferencing tools for hybrid learning (Jamil & Muschert, 2023).

The integration of Information and Communication Technologies in higher education, particularly within

public sector institutions, has seen significant advancements over the past two decades (Mushimiyimana et al., 2022). These developments have been pivotal in enhancing educational delivery, research capabilities, and administrative efficiencies across universities in Pakistan (Ahmad & Sheikh, 2021b).

In 2002, the Government of Pakistan established the Virtual University of Pakistan (VU), the nation's first institution dedicated entirely to modern ICT-based education (Hussain et al., 2019). VU leverages e-learning methodologies to offer undergraduate, postgraduate, and doctoral programs across various disciplines. Its reliance on internet-based lectures has enabled Pakistani students, both domestically and internationally, to access quality education remotely (Reyes et al., 2017).

Similarly, the Allama Iqbal Open University has embraced e-learning by providing virtual classrooms and interactive online study materials. As one of the world's largest distance learning institutions, AIOU offers programs ranging from secondary schooling to PhD levels, catering to a diverse student body across Pakistan (I. Hussain, 2018).

The Higher Education Commission of Pakistan has played a crucial role in promoting ICT integration within higher education. In the early 2000s, the HEC launched several reforms aimed at enhancing access to digital resources and improving the quality of education through technology (Noreen & Malik, 2019). One notable initiative was the introduction of video conferencing facilities to bridge the gap between students and educators, especially in remote areas. This initiative facilitated interactive lectures and meetings across more than 150 universities nationwide (T. Khan et al., 2018).

In contemporary academic settings, students utilize a diverse array of Information and Communication Technology (ICT) resources to enhance their learning experiences. These tools range from digital libraries and e-journals to educational applications and intelligent tutoring systems (Guerra-Liaño et al., 2010). The most important one of ICT tools is Digital libraries which provide students with access to vast repositories of academic materials, including books, research papers, and multimedia content (Strutynska & Umryk, 2017). Platforms like Docsity exemplify this trend, offering a social learning network where students can share and access study materials across various subjects. As of mid-2012, Docsity expanded internationally, providing over 3 million study documents and engaging more than 15 million registered students worldwide.

The success of the ICT materials can be understood by the frequency of the usages, thus, the frequency of ICT usage among students has been a widely studied area, particularly in understanding how digital resources shape learning behaviors in higher education (Van Den Berg et al., 2012). Studies indicate that ICT usage frequency varies significantly based on academic demands, course structure, and institutional infrastructure (AZMI, 2019). A study by Mostofi, (2022) found that over 60% of university students use ICT resources daily, primarily for online research, exam preparation, and assignments. However, variations exist across disciplines; students in STEM fields tend to have higher ICT usage rates than those in humanities, as their coursework often requires access to specialized software, online simulations, and digital repositories (Hosein et al., 2010).

Infrastructure availability also plays a critical role in ICT usage frequency. Students at institutions with well-equipped libraries, digital learning centers, and Wi-Fi-enabled classrooms tend to use ICT resources more frequently than those at universities with limited digital infrastructure (Ahmad & Arshad, 2021). According to a survey by Sahebrao (2019), students who receive training on ICT-based tools as part of their coursework exhibit higher engagement with digital resources compared to those who rely on self-learning. Additionally, faculty encouragement and digital literacy programs significantly impact ICT adoption rates (Batool, 2021).

The location of ICT access influences both the quality and frequency of students' engagement with digital learning resources. On-campus ICT facilities, such as computer labs, library access to digital databases, and university-provided e-learning platforms, serve as primary access points for students without personal ICT devices (Vedantham et al., 2022). Lomos, Luyten, and Tieck (2023) found that over 70% of students in public universities in Pakistan rely on university-provided ICT infrastructure due to financial limitations preventing them from owning high-end personal devices.

On the other hand, off-campus ICT access, particularly through mobile phones and home internet connections—has become increasingly prevalent (Ongondo & Williams, 2011). With the rise of smartphones and affordable internet services, a significant shift has been observed towards mobile-based learning. Research indicates that more than 75% of university students prefer using ICT resources via smartphones, as it allows them greater flexibility to access digital content anytime and anywhere (Rahman et al., 2023). However, challenges such as slow internet speed, power outages, and expensive mobile data plans limit ICT usage in developing regions (Mwikamba et al., 2024).

Additionally, social factors influence ICT access points. While students in Western countries predominantly access digital content from personal laptops at home, research from developing nations suggests that a majority of students still depend on university computer labs for ICT usage due to economic constraints (Hoque & Sorwar, 2017). Institutional policies, such as the availability of digital libraries and the integration of ICT in classroom learning, further shape ICT access patterns (Thapa & Sæbø, 2014).

The adoption of Information and Communication Technologies (ICTs) in education is significantly influenced by technological and infrastructural limitations, particularly in developing regions (Ntorukiri et al., 2022). Unstable power supply, slow internet connections, and inadequate digital infrastructure are among the most frequently cited barriers in research on ICT integration in higher education (Rangel-Pérez et al., 2021).

One of the most pressing infrastructural challenges is unstable power supply, which directly affects students' ability to use ICT resources. In many developing countries, frequent power outages disrupt access to online educational platforms, limit the use of digital libraries, and hinder students from completing assignments and research activities on time (Adarkwah, 2020). On average students lose 4 to 6 hours of ICT access daily due to power cuts, making it difficult for them to rely on technology-driven education. Universities in resource-constrained settings often lack backup power solutions such as generators or solar energy, further exacerbating the problem (Rangel-Pérez et al., 2021b).

Another major issue is slow and unreliable internet connection. Many institutions in developing regions lack high-speed internet, which significantly hampers access to online research materials, virtual classrooms, and cloud-based educational tools (Siddiquah & Salim, 2017).

In West African universities over 65% of students experience difficulties in loading online academic materials due to poor bandwidth availability (Anser et al., 2021). Similarly, a study in Pakistani universities by (Ishaq et al., 2020) found that students in rural and underdeveloped areas face prolonged disruptions in internet access, forcing them to rely on printed materials rather than digital resources. This digital divide between urban and rural institutions creates disparities in students' ability to leverage ICT for academic success.

Furthermore, inadequate ICT infrastructure continues to be a significant hindrance (Karakara & Osabuohien, 2020). Many universities in developing countries struggle with outdated computer labs, limited availability of digital devices, and a lack of modern learning management systems (Liesa-Orús et al., 2020). Libraries and IT centers in many public sector universities are underfunded, leading to a shortage of essential ICT tools such as projectors, smart boards, and high-speed servers. The lack of well-maintained ICT resources forces students to rely on personal devices, which not all can afford (Zarei & Mohammadi, 2021).

One of the key barriers to effective ICT adoption in higher education is the lack of digital proficiency among students, which directly impacts their ability to retrieve, evaluate, and utilize online information for academic success. Research indicates that many students, particularly in developing regions, lack the necessary skills to navigate complex digital databases, use advanced search strategies, or critically assess online information (Jameel, 2018). According to Asamoah (2020), while most undergraduate students are familiar with basic ICT tools, such as Google searches and Microsoft Office, they struggle with advanced ICT applications like online databases, e-journal access, and academic referencing software. This gap in digital literacy often results in inefficient information retrieval, reliance on low-quality sources, and challenges in managing digital academic tasks.

A study by Ng and Yunus (2021), found that undergraduate students often resort to trial-and-error methods when searching for academic materials online, leading to increased frustration and wasted time. Mynaříková and Novotný (2021) further highlight that students who are not well-versed in ICT tools tend to depend on general search engines rather than subject-specific databases, thereby limiting the quality and depth of their research. This deficiency in ICT literacy becomes even more critical as universities shift toward digital learning environments and online assessment models.

The lack of formal training in ICT proficiency is a major factor contributing to students' struggles with digital academic tools. Many universities provide computer labs and digital resources, there is often no structured training to help students maximize their use (Adam & Tatnall, 2017). Many students enter university with only rudimentary ICT skills and are expected to learn complex software applications such as SPSS for data analysis, EndNote for citation management, or digital library navigation systems (Iivari et al., 2018). Issues like these sults in low adoption rates of advanced ICT tools, with students either avoiding these platforms altogether or using them inefficiently (Bundsgaard, 2019).

Research Methodolgy

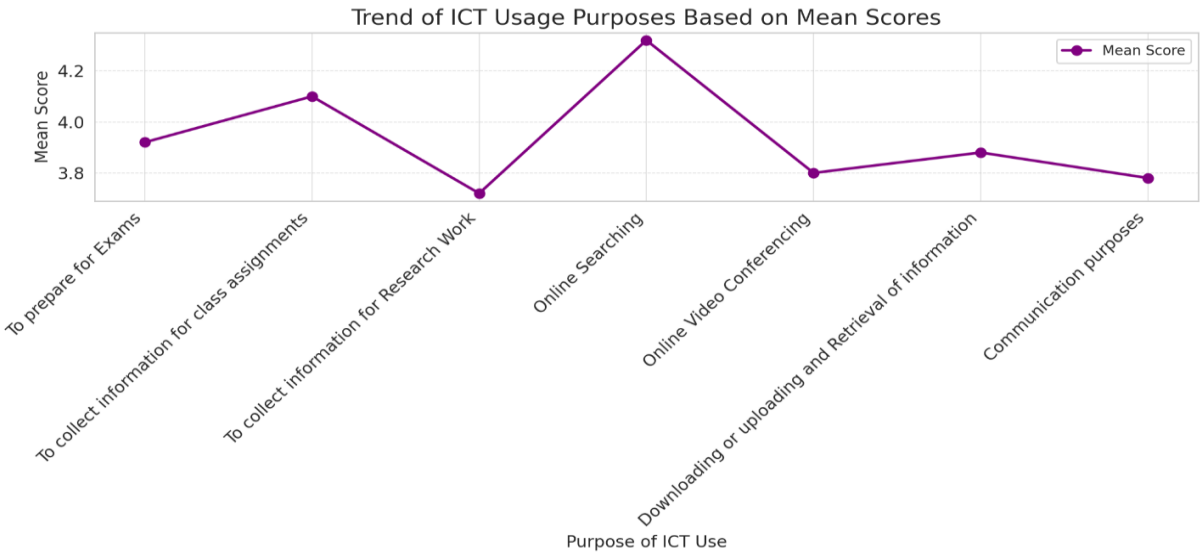
This study adopted a quantitative research approach using a survey research design to examine ICT-based information retrieval patterns among undergraduate students in public sector universities in Peshawar. The target population comprised final-semester undergraduate students from the University of Peshawar and Islamia College University (Chartered University), selected based on their academic reputation and ICT resource availability. The total student population was 3,050, and using the Raosoft Sample Size Calculator, a sample of 342 students was determined, out of which 290 responded positively, yielding a response rate of 84.79%. Data were collected using a structured questionnaire, designed after reviewing existing literature, expert consultations, and prior studies on ICT adoption and academic performance. The questionnaire covered demographics, ICT usage frequency and purpose, access points, challenges, and perceived impact on learning outcomes. To ensure validity and reliability, senior researchers reviewed the questionnaire for content accuracy, and Cronbach's Alpha reliability test indicated an internal consistency ranging from 0.63 to 0.77. The survey was administered both in-person and electronically, with informed consent obtained from all participants. Ethical research standards were upheld, ensuring confidentiality, voluntary participation, and anonymity of responses. Data analysis was conducted using SPSS (Version 19), applying descriptive statistics such as mean, standard deviation, and percentage distribution, alongside inferential analysis to examine relationships between ICT usage frequency and academic performance. This structured methodological approach ensured a rigorous, reliable, and ethical investigation into the impact of ICT-based resources on student learning outcomes.

Results

The findings of this study reveal that ICT-based resources play a significant role in students' learning experiences and academic performance. The analysis provides insights into students' ICT usage frequency, access points, purpose of use, and the impact of these resources on their education.

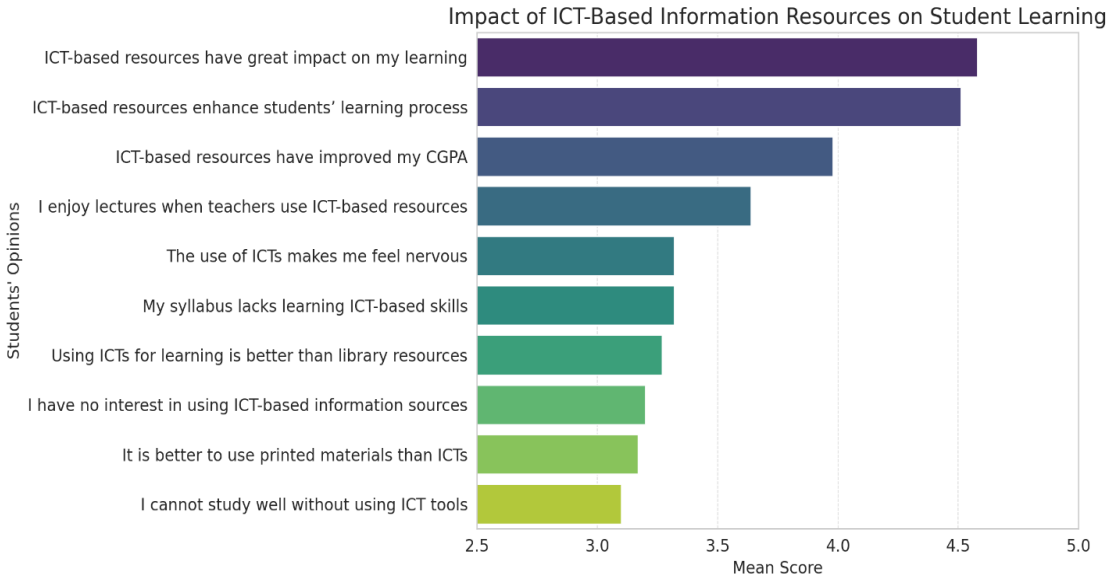
Purpose of using ICT

The line graph illustrates the trend of ICT usage purposes based on mean scores, highlighting that online searching (Mean = 4.32) and class assignments (Mean = 4.10) are the most common uses, while research-related activities (Mean = 3.72) rank lower. The moderate mean score for exam preparation (Mean = 3.92) and information retrieval (Mean = 3.88) suggests that students utilize ICT resources primarily for coursework rather than extensive research. The overall trend indicates that while ICT plays a crucial role in academic activities, its use for deeper research purposes remains relatively underutilized.



Impacts of ICT based learning

The bar chart visually represents students' perceptions of the impact of ICT-based information resources on learning outcomes, based on mean scores. The findings indicate that students strongly believe ICT enhances learning (Mean = 4.58) and improves the learning process (Mean = 4.51). Additionally, many students agree that ICT positively influences their CGPA (Mean = 3.98) and makes lectures more engaging (Mean = 3.64). However, responses regarding ICT completely replacing traditional learning methods were more moderate, with lower mean scores for preferring ICT over printed materials (Mean = 3.17) and not being able to study without ICT (Mean = 3.10). These results suggest that while ICT is widely accepted as an effective learning tool, students still value traditional learning resources alongside digital ones.



Discussion

The findings of this study highlight the significant role of ICT-based resources in enhancing student learning outcomes, with a particular emphasis on learning engagement, academic performance, and accessibility of digital tools. The study revealed that a majority of

students use ICT resources daily (62.06%), with mobile devices serving as the primary access point (72.41%), demonstrating the growing shift toward mobile learning and digital flexibility. This aligns with previous research (Jolselt, 2020; Bankole & Adio, 2018) indicating that mobile technology has become an essential medium for academic information retrieval and student engagement.

The purpose of ICT usage among students further supports these trends, with online searching (Mean = 4.32) and exam preparation (Mean = 3.92) emerging as the most common activities. While students acknowledge ICT's value in academic performance, its use for research activities (Mean = 3.72) remains relatively lower. These findings suggest that undergraduate students primarily leverage ICT for immediate academic needs, such as coursework and exams, rather than for in-depth research. This observation is consistent with Batool (2021), who found that students often lack the training and motivation to explore ICT-based scholarly databases extensively.

A notable impact of ICT resources on academic performance was observed, with students affirming that ICT enhances their learning experience (Mean = 4.58) and improves learning processes (Mean = 4.51). Additionally, the perceived improvement in CGPA (Mean = 3.98) supports the argument that students who effectively integrate ICT into their studies tend to achieve better academic outcomes (Rafiq et al., 2021). However, the preference for ICT over traditional printed materials (Mean = 3.17) was found to be moderate, suggesting that while students appreciate ICT, they still find printed resources valuable. This aligns with the literature suggesting that blended learning approaches—incorporating both digital and traditional resources—are often more effective (Chakraborty et al., 2018).

Despite these benefits, several challenges hinder effective ICT adoption. Unstable power supply, slow internet connectivity, and lack of ICT proficiency were found to be major obstacles, consistent with previous studies (Agboola et al., 2023; Ahmad & Arshad, 2021). Furthermore, limited training on ICT tools prevents students from utilizing advanced features such as digital research databases and citation management tools, affecting their academic depth. Addressing these challenges through university-led digital literacy programs, improved ICT infrastructure, and internet accessibility initiatives could significantly enhance ICT's effectiveness in higher education.

Conclusion

Recommendations

1. Implement Structured ICT Literacy Programs

To bridge the digital proficiency gap, universities should integrate mandatory ICT literacy courses into the curriculum. The study findings reveal that many students lack advanced ICT skills, which affects their ability to effectively search, retrieve, and use digital academic resources. Universities should introduce formal training on database navigation, academic search techniques, citation management, and plagiarism detection tools. Additionally, regular workshops and hands-on training sessions conducted by university libraries and IT departments can further enhance students' ability to maximize ICT for learning and research.

2. Improve ICT Infrastructure and Internet Connectivity

The study highlights that unstable power supply (Mean = 4.56) and slow internet connectivity are major obstacles limiting students' effective use of ICT-based resources. Universities should invest in alternative power solutions, such as solar energy backup systems, to ensure uninterrupted internet access and digital learning facilities. Additionally, there is a need for broadband expansion and improved Wi-Fi access on campuses to support online learning. Collaborations with government agencies and private technology firms can help provide subsidized internet plans for students, ensuring equitable digital access for all.

3. Expand Access to Digital Academic Resources

Although students heavily use ICT for online searching (Mean = 4.32) and exam preparation (Mean = 3.92), their use of ICT for in-depth research remains lower (Mean = 3.72). Universities should increase subscriptions to digital libraries, e-journals, and research databases to ensure that students have access to high-quality, peer-reviewed academic materials. Additionally, library portals should be regularly

updated and simplified, making it easier for students to navigate and retrieve relevant scholarly resources.

4. Encourage a Blended Learning Approach

The findings show that students still value printed materials, with only moderate preference for ICT over traditional resources (Mean = 3.17). This suggests that while ICT plays a crucial role, a balanced approach to learning is necessary. Universities should implement hybrid learning models, combining digital platforms with conventional teaching methods to support different learning styles. This approach ensures that students can maximize both technology-driven and traditional educational resources, leading to a more comprehensive and effective learning experience.

5. Address Challenges in ICT Adoption

Several challenges hinder ICT adoption, including lack of ICT literacy (Mean = 3.22) and limited information retrieval skills (Mean = 4.41). Universities must ensure that faculty and library staff receive advanced ICT training, enabling them to support students in digital resource utilization. Additionally, technical support teams should be readily available to assist students in troubleshooting ICT-related challenges.

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