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Developing and Evaluating Digital Teaching-Learning Resources in Pakistani Higher Education: Evidence from a Meta-Analytic Review

Syed Izatullah
Department of Education, University of Management and Technology, Lahore, Pakistan
s2025095006@umt.edu.pk
Rabeeya Nasir
MPhil Educational Leadership and Management
rabeeyanasir@gmail.com
Dr. Afshan Naseem
Department of Education, University of Management and Technology, Lahore, Pakistan
Corresponding Author: afshan.naseem@umt.edu.pk

Abstract

With increasingly generative artificial intelligence (GenAI) and advanced digital technology tools becoming widespread in the higher education sector in Pakistan, the degree to which the technological adoption can have a substantive impact on student academic success has been a question to be answered. The current paper summarizes the empirical findings on the subject using a systematic meta-analysis as the aim is to inform the creation of evidence-based tools in digital teaching and learning. Systematic review was performed on quantitative studies that were published between 2002 and 2022 according to the PRISMA guidelines. Six qualified studies, which were carried out in Pakistani universities and a sample of 2568 individuals, were examined through a random-effects model to reveal the estimate of the standardized mean differences (Hedges g).

The overall effect size was g = 0.326 (p = 0.072) indicating a small positive correlation between the use of technology and academic success, but which does not achieve the traditional levels of statistical significance. The heterogeneity between studies was substantial ($\tau^2 = 0.14$; $I^2 = 99.03\%$), which means that there is large variation in the effectiveness of technology integration. Moderator analysis demonstrated that there was statistically significant effect of educational level ($p < .001$), with digital technologies providing stronger academic advantage to postgraduate (MPhil/PhD) groups compared to the undergraduate participants.

These findings challenge the belief that simple digital access multiplication is bound to be converted into improved learning performance, thus pointing out a long-standing gap between digital literacy and academic performance. To fill this gap, the study supports the paradigm shift to the interventions that are infrastructure based to pedagogy-based resource building. Particularly, it suggests designing strictly structured, scaffolded digital tools specifically suited to the needs of undergraduate students and the more open, less architectural research tools addressing the needs of postgraduate researchers, to make sure that future investments in educational technology are more about instructional design than about incidental digitalization.

Keywords: *Academic Achievement, Digital Resources, Instructional Design, Meta-Analysis, Technology Integration.*

Introduction

Technology has changed into a supportive teaching tool to a cornerstone of the modern pedagogical methodology. The accelerated shift in Pakistan has been made possible by post-pandemic education necessities and the fast progression of advanced digital technologies, i.e., Generative Artificial Intelligence (GenAI). With universities striving to modernize the teaching and learning process, the creation of efficient digital teaching-learning tools has become a priority issue to the Higher Education Commission (HEC) and individual institutions, both state and privately, nationwide. However, there is a question that has not been answered yet, and that is, does the simple incorporation of educational technology create any tangible benefits to the academic performance of students?

The use of technology in Pakistani higher education is a wide field, starting with simple Learning Management Systems (LMS) and multimedia projectors and ending with more advanced AI-enabled adaptive learning systems. Advocates of digital learning say that these tools increase the informational access, promote self-directed learning, and improve student engagement. Empirical data supports these arguments, albeit to a smaller degree, and the recent research shows increased motivation and engagement among the university students, especially in urbanized academic settings like Lahore (Uzma & Nasreen, 2024).

Nevertheless, there is conflicting evidence as to the effect of technology on academic performance, which is generally determined by GPA (or standardized test scores). Some studies have indicated statistically significant returns but others warn that ill-thought technology or misaligned technology may prove more distracting than educative and thus defeat the learning process. Munir et al. (2024) reveal that this complexity is evident by the fact that, though the digital literacy rates among students of Lahore university were high, the correlation with CGPA was positive but insignificant. This fact highlights the eternal paradox: the very fact of availability of technology does not necessarily bring academic success. Instead, the quality of pedagogy and curriculum congruence of digital materials seem to be defining elements.

This has been complicated by the rapid development of Generative AI tools. Despite the fact that these technologies provide a unique approach to academic assistance and increased efficiency, the proximity to academic honesty and the possibility of losing critical thinking are also issues that arise when applied without a well-thought pedagogical system (HEC, 2024). The latest suggestions of the English policy also stress the urgency of responsible AI models and robust digital infrastructure, especially to reduce the digital divide in rural and underserved student groups (MOITT, 2024; Jamil et al., 2024). Thus, the educational stakeholders are gradually drifting away the approach of adopting technology and moving to the systematic assessment of digital resources and their pedagogical appropriateness.

Although there are increasing amounts of individual studies, there is a clear paucity of synthesized empirical research studies on technology integration in the particular context of Pakistani higher education. The available meta-analyses have been largely based on Western contexts of education or general K-12 populations and have frequently failed to consider the structural, cultural and socio-economic realities of Pakistani higher education institutions. Such a contextual gap constrains the evidence-based policymaking and creates a danger of further investment in digital programs that might not produce significant academic results.

Rationale and Objectives of the study

This paper aims to address the specified gap in literature by performing a meta-analysis of the empirical studies published in the years 2002-2022. The review will approximate the extent of the relationship between technology integration and academic achievement in the Pakistani Higher Education Institutions (HEI) setting by conducting a synthesis of quantitative data on

research that has been conducted on the subject, by employing students studying in these institutions.

There are two main objectives that guide the study. First, it will set a statistical baseline that will depict the historical influence of educational technology on the student academic achievement in Pakistan. Second, it attempts to apply these empirical results into practical knowledge in the creation and testing of future digital teaching-learning tools, and with the focus being on pedagogical efficacy and not on digital adoption.

Besides, the analysis also looks at the key moderating variables such as level of education (undergraduate and postgraduate) and sample size in explaining variability in reported outcomes. As a result, the given study gives context-specific information to the instructional designers, academic leaders, or policy-makers involved in the curriculum reform, the digital transformation process, or the establishment of new Faculties of Education in the region.

Literature Review

Higher Education Technology: Access to Pedagogical Effectiveness

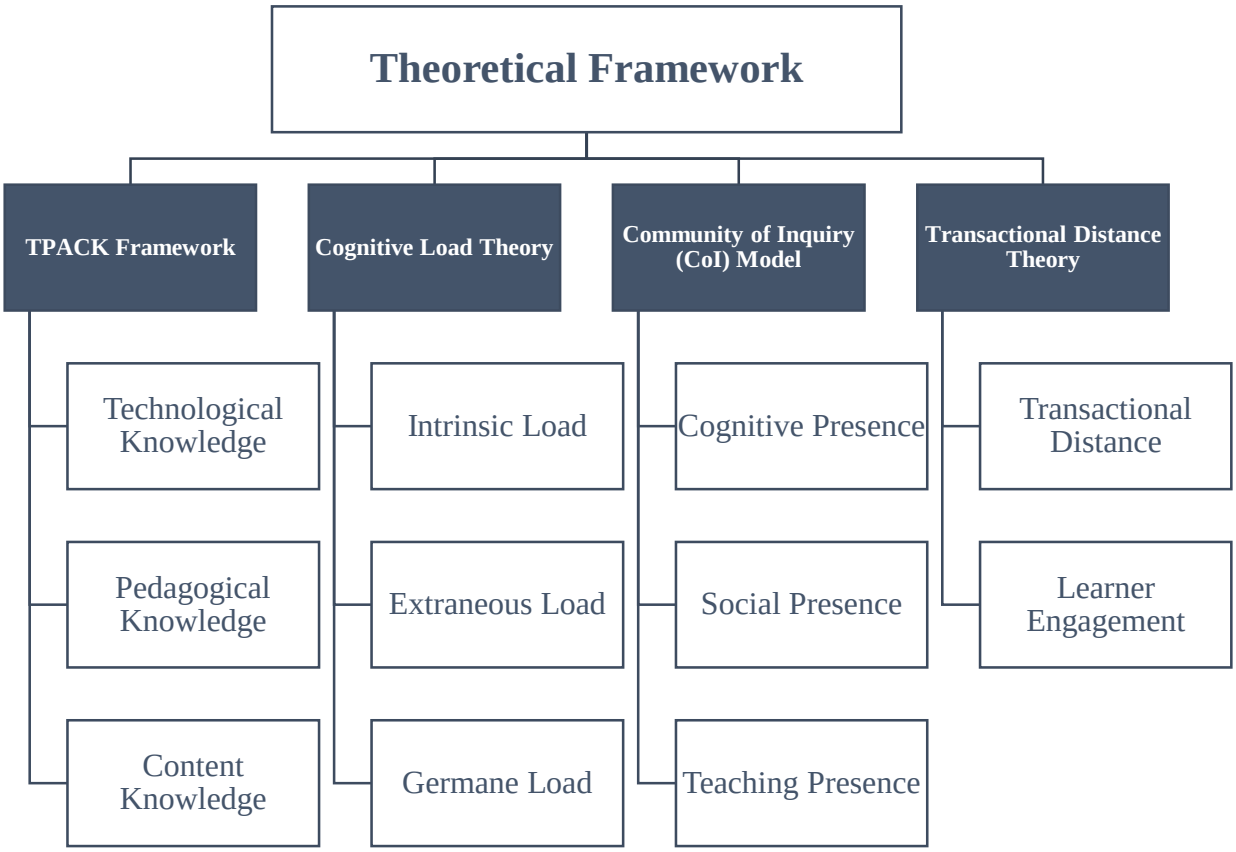
There has been a gradual change in the dialogue of technology in higher education, where issues of access and availability have been substituted on questions of effectiveness in pedagogy and instructional integration. Instead of posing the question of the presence of technology in the learning contexts, the scholarly work of recent times is more concerned with the design, implementation, and alignment of digital tools with the learning purposes. This part examines the theoretical background informing the current research and summarizes empirical data in the Pakistani context of higher education, as well as takes into consideration the new challenges posed by the period of Generative Artificial Intelligence (GenAI).

Theoretical Framework: TPACK and Digital Constructivism

In order to develop the conceptualization of the relationship between the integration of technologies and academic achievement, this paper relies on the Technological Pedagogical Content Knowledge (TPACK) model suggested by Mishra and Koehler (2006). The TPACK model assumes that the successful technology-enhanced teaching is a result of the dynamic interaction of three fundamental domains, including content knowledge, pedagogical knowledge, and technological knowledge. The framework, as shown in Figure 1, focuses on the fact that technology is only educationally meaningful when pedagogically based and content-specific, and not when applied alone.

In the framework of Pakistani higher education, successful technology implementation is not limited to the availability of digital infrastructure or hardware in classrooms. It involves using the interaction of pedagogy, content, and technology to guide the learning processes in a competent manner. The latest additions to the TPACK model have brought the notion of Intelligent-TPACK, which preempts AI literacy as a critical skill of a modern teacher (Ning et al., 2024). This changed view is an indication of the increasing role of AI-based tools in education. Devoid of such pedagogic congruency and didactic purpose, digital technologies will likely serve as expensive supplements or burdens to learning, instead of cognitive scaffolds that can promote learning among students.

Figure 1:
Theoretical Framework



Technology Integration and Academic Achievement: Empirical Evidence

The interaction between technology use and academic performance of students in Pakistan has been complex and even contradictory in the past. Although an ever-expanding research base in the educational potential of digital tools is pointing out the possibilities of the digital tool on student performance, empirical evidence indicates that the given effect depends on the way the digital tool is utilized and applied to the educational process.

Indications of Positive Academic Effect

Some research studies that have been conducted in Pakistani institutions of higher learning indicate that there is a positive relationship between the use of technology and academic performance especially where digital technologies are used to supplement traditional teaching and learning processes. Studies by Shuja et al. (2019) and Rashid and Asghar (2016) show that blended learning methods, in which technology is used to complement face-to-face teaching, can be a very effective method to improve conceptual learning and knowledge retention in students. The results are in harmony with constructivist theories of learning, which prefigures active involvement and building knowledge. Digital technologies, in such contexts, have been used as interactive learning environments, which encourage inquiry, make teachers think, and learners gain independence through, and not simply as passive channels of consumption.

Digital Distraction and Non-Significant Outcomes

Other empirical studies, on the other hand, point to the constraints and possible negative aspects of unstructured technology use. Reviewed evidence in this meta-analysis suggests that overuse of social media sites and uncontrolled internet browsing is usually correlated with poor grades, in terms of GPA. An especially exemplary case is given by Munir et al. (2024), who discovered what they referred to as a Digital Literacy Paradox in universities in Lahore. Even though students

showed strong operational digital abilities, the latter did not lead to the statistically significant advances in CGPA ($p > .05$). This observation implies that technical competency is not enough, students might not have the academic digital literacy to critically use digital resources in higher-order learning and academic work.

Generative AI as an Emerging Challenge in Pakistani HEIs

The current technological realities of the academic year 2023 saw the emergence of Generative Artificial Intelligence instruments, such as ChatGPT and Claude, that pertain to the technological world in a manner that contradicts previous studies. Although GenAI applications can provide more support than ever in academic writing, research, and idea generation, they have brought with them a number of important pedagogical and ethical issues. Surveys conducted recently indicate that even though such tools can enhance confidence of students and make them less time-consuming in performing specific tasks, their uncontrolled use can help to deteriorate their critical thinking and make them more dependent on the results of automated programs. Abbas et al. (2024) have shown that the most common and unmonitored usage of ChatGPT by university students in Pakistan was associated with higher rates of procrastination and lower retention of central subject matter during exams.

In addition to the learning behaviors of individual learners, GenAI has also raised the issue of assessment validity. According to Cotton et al. (2024), traditional assessment models, especially take-home written tests, are no longer considered effective predictors of student performance in the current setting with highly developed generative technology. This change requires the transition into process-based and authentic assessment approaches which focus not only on the end products, but also on learning paths, reasoning and skill building.

Pakistan: contextual barriers to technology effectiveness

Educational technology also varies in effectiveness in contextual and infrastructural considerations in Pakistan. Despite projects like the Higher Education Commission project of Smart Universities, the digital divide is still a major moderating factor. The students studying at the universities, which are not located in big cities, e.g. Lahore and Islamabad, often face the problem of the low level of internet connection and unreliable power. Interruptive behavior of this kind undermines the continuity and integrity of online learning experiences (Uzma and Nasreen, 2024), and therefore has a comparable impact on perceived learning outcomes, which is the focus of the interpretation that this meta-analysis seeks to explain.

Summary of the Research Gap

Despite the current literature reviewing the area of technology utilization, digital literacy, and the new AI tools separately, there is still no unified evidence to measure the total effect of technology integration at various levels of education and disciplinary backgrounds in Pakistani higher education. Specifically, little focus has been given to the issue of the role of technology in influencing undergraduate and postgraduate learners in different ways. The gap that is filled by this meta-analysis is the synthesis of empirical evidence about two decades of research concerning the question of whether the promise of digital education in Pakistan that has long existed has been turned into measurable academic gains.

Methodology

Research Design

The research design used in this study was meta-analytic research design in order to quantitatively synthesize the findings on the effect of technology integration on academic performance in Pakistani Higher Education. Transparency, methodological rigor and ease of reproducibility of the results will follow the guidelines of the Preferred Reporting Items systematical reviews and meta-analyses guidelines (PRISMA) (Page et al., 2021).

Search Strategy and Data Sources

To recognize the studies that are relevant and published in 2002-2022, a systematic literature search was conducted. The time frame was selected to represent 20 years of technological change and subsequent alterations in teaching methodology in the Pakistani higher education industry.

A search was done in five key electronic databases including Scopus, JSTOR, Springer, Taylor and Francis, and ERIC. The search strategy was a structured Boolean search approach that entailed the combination of keywords in three domains of concepts to provide an exhaustive coverage of the literature. Such domains were technology terms (e.g., instructional technologies, educational technology, classroom technology, technology integration), outcome terms (e.g., academic achievement, student performance, GPA, learning outcomes), and context-specific terms (e.g., higher education, universities, Pakistan).

The targeted classification of keywords promoted the accuracy and scope of search process, through which it was possible to find the studies that covered the multidimensional nature of technology integration in higher education. Table 1 gives a detailed list of search terms used under each category.

Table 1

Search terms included in the systematic review

Category	Search terms
Technology	Instructional Technologies, Technology in Classroom, Technology, Educational Technology, Instructional Technology, Instructional Technology, Classroom Technology
Students' Achievement	Achievement, Performance, Student Performance, Academic Performance, Student Achievement, Academic Achievement, Class Performance, Class Achievement
Higher Education	Higher Education, Technology in Higher Education, Computers in Universities, Computers in Higher Education,

Inclusion and Exclusion Criteria

The identification of all studies was followed by a systematic screening of the articles based on set eligibility criteria. In order to be included in the meta-analysis, a study had to satisfy the following:

Context: This was done in a higher education institution (HEI) in Pakistan.

Intervention: The discussion of computer technology (e.g., LMS, mobile applications, social media) as the annexal instructional aid.

Output: A report on quantitative results about academic achievement or performance of students (e.g., grades, test scores).

Design: Adequacy of statistical information (sample size, mean, standard deviation, or correlation coefficients) is provided so that the calculation of the effect-size can be made.

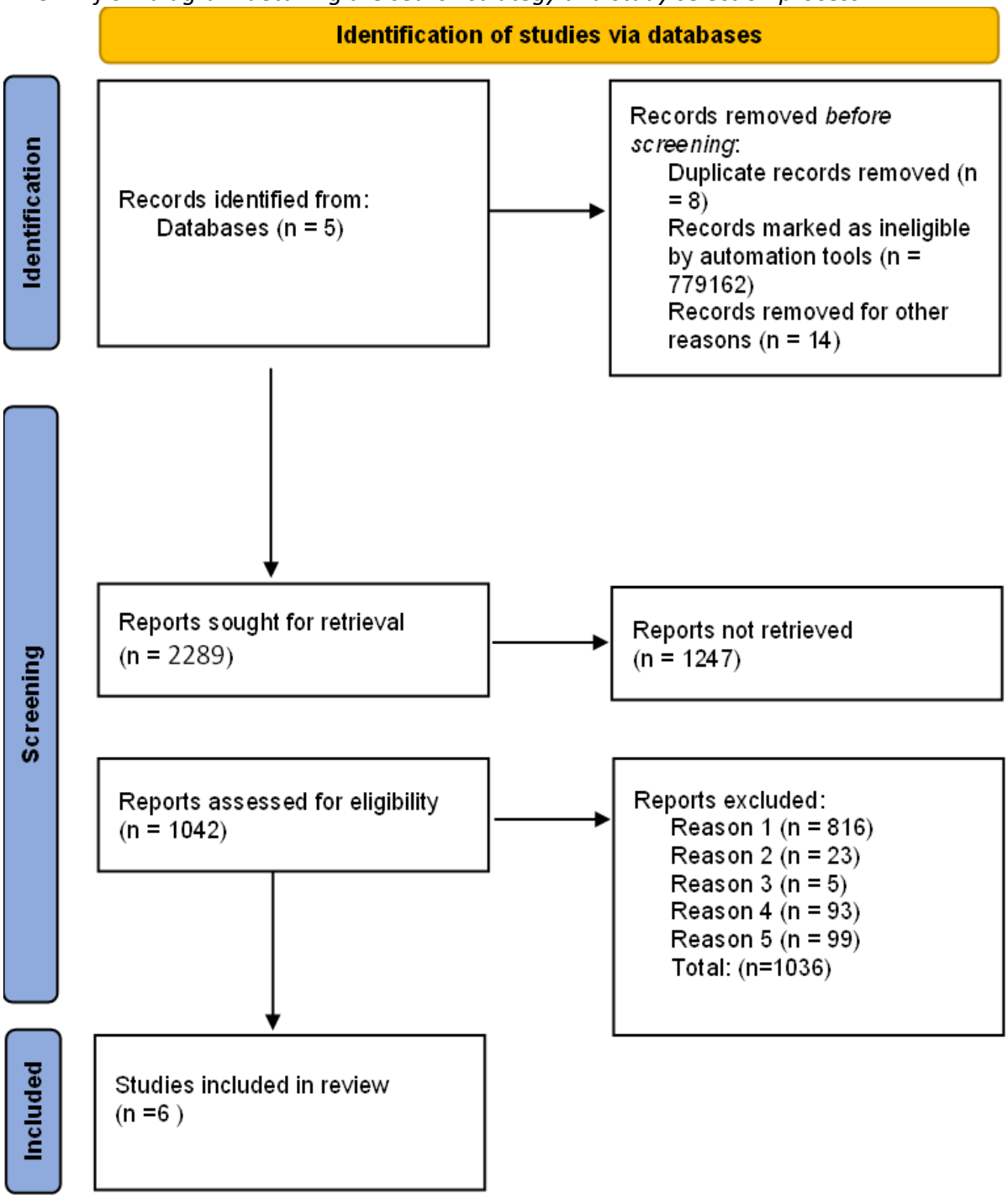
Articles were filtered out in case they used a purely qualitative research design, had insufficient statistical data, or were in the context of primary or secondary education instead of a higher education.

Selection Process

The PRISMA framework was followed in the study selection process in order to provide transparency and consistency in methodology. Records located with the help of database search were filtered and addressed to determine their eligibility based on preset inclusion criteria as shown in the PRISMA flow diagram (Figure 2). This preliminary selection procedure guaranteed correctness and integrity of the ultimate dataset, which subsequently boosted the credibility of the subsequent meta-analytic results.

Figure 2

PRISMA flow diagram detailing the search strategy and study selection process



Study Selection and Data Extraction

This was carried out through the selection of studies and extraction of data. The first search resulted in 1,042 records. Table 2 contains detailed descriptions of the studies that were excluded and the reasons.

Table 2

Details of excluded studies and reasons for their exclusion

S. No.	Reason for Exclusion	Number of Studies
1	Overall Irrelevant Studies	816
2	Not of Higher Education	23
3	Not of Pakistan	5
4	Variables not same as required	93
5	Duplicate studies	99

Following elimination of duplicates and two rounds of screening procedure (title/abstract and full-text review) six studies that fit all inclusion criteria were identified and included in the final meta-analysis. Standardized coding form was used in extraction of data. The most important variables were the characteristics of the study (author, year), the demographics of the participants (sample size, educational level), type of technology (e.g., mobile learning, simulations), and statistical results (mean, SD, r-values). To reduce bias, 2 independent reviewers evaluating the sites of included studies on a methodological quality scale were involved.

Justification of Methodological Inclusion of the Study (k = 6)

Even though the ultimate sample included six studies (k = 6), this is the number of studies used in accepted meta-analytic methods in new research fields and geographically limited situations. According to Borenstein et al. (2009), meta-analysis is still a valid and informative technique even in the case of a small number of studies that were included, as long as the selection of studies was carried out in a systematic, transparent, and methodologically sound way.

In the framework of Pakistani tertiary education, quantitative research with a strong research strength to provide adequate statistical data, including means, standard deviations, and sample sizes, is not common. As such the quality of the methodology was considered serious and intentional. Research articles that failed to present their statistics clearly or those who combined higher education with either primary or secondary education samples have been excluded in a bid to have an analytical consistency. By being this strict in terms of inclusion this reduced the impact of incomparable or methodologically weak data and meant the resulting effect size estimates were reliable and interpretable. In line with this, the meta-analysis gives a high-confidence base to comprehend the effect of integrating technology on academic performance of students in Pakistani institutions of higher learning.

Data Analysis

The statistical analyses were carried out to consolidate the effect sizes, as well as test the variability among the included studies. Seeing that the research designs are varied, the standardization of the effect sizes was initially introduced to allow meaningful comparison. In a correlational study, the r values of Pearson were transformed into a standard effect size whereas in an experimental study, Cohen's d was determined through means and pooled standard deviations that were reported.

In order to include variations in the precision of the studies, the inverse variance weighting method was used and the studies that had large sample sizes and low variances were weighed

accordingly to contribute more to the pooled estimate. The Cochran Q statistics and the I^2 index were used to evaluate heterogeneity; the I^2 index with a value of more than 75% was considered to represent a significant degree of heterogeneity, thus justifying the utilization of a random-effects model. Moderator analyses investigated possible variability sources of effect sizes. Subgroup analyses were carried out to identify whether the impact of technology integration varied according to important moderators (sample size and level of education) such as BS, MS, PhD.

Results

The systematic literature search included the last 20 years (2002-2022) to reflect the development of technology implementation in the Pakistani higher education. After the use of severe inclusion criteria, six quantitative studies (k 6) were considered to satisfy all inclusion criteria. It is particularly notable that all of the included studies were published within the year 2018 to 2021, which gives it a temporal focus that appears to indicate systematic quantitative research of educational technology effects have only happened in the recent years, which could be attributed to the rise in digitization of the world during or after the COVID-19 pandemic.

The last sample consisted of 2,568 students who were selected in various Pakistani universities. The studies included covered a variety of levels of education undergraduate (BS) studies to doctoral (PhD) studies and considered various types of technology integration, such as Learning Management Systems (LMS), learning tools based on social media and computer-based approaches to instruction.

Included Studies Characteristics

Table 3 shows the descriptive features of the studies that were included. There were four studies that targeted undergraduate (BS) students with only two studies including postgraduate cohorts (MS/MPhil/PhD). The distribution shows that there is a definite focus on empirical studies at the undergraduate level, and the focus on postgraduate learners is relatively low.

Table 3

Summary Statistics of Included Studies

Study	Mean Effect Size	Standard Deviation	Sample Size	Male	Female	Research Method	Study Design
Javed et al., 2018	-0.139	0.0559	316	129	187	Quantitative	Correlational
Shuja et al., 2019	0.590	0.0569	203	109	94	Quantitative	Correlational
Aqeel et al., 2019	0.007	0.2887	14	NA	NA	Quantitative	Correlational
Abbas et al., 2019	-0.025	0.0354	800	NA	NA	Mixed Method	Correlational
Rafay et al., 2019	0.462	0.0602	203	118	85	Quantitative	Correlational
Ahmad & Sheikh, 2021	0.958	0.0173	275	50	225	Quantitative	Correlational

This is a summary of how technology has affected academic achievement across the board.

The meta -analysis employed a random-effects model because of vast difference in study designs and population.

Overall Effect Size: According to Table 4, the pooled overall effect size (Hedges' *g*) was 0.326 which is a small to medium positive effect following the guidelines of Cohen.

Table 4

Overall Effect Size Estimates

	Effect Size	Std. Error	Z	Sig. (2-tailed)	95% Confidence Interval		95% Prediction Interval[a]	
					Lower	Upper	Lower	Upper
Overall	.326	.1811	1.799	.072	-.029	.681	-.969	1.620

a. Based on t-distribution.

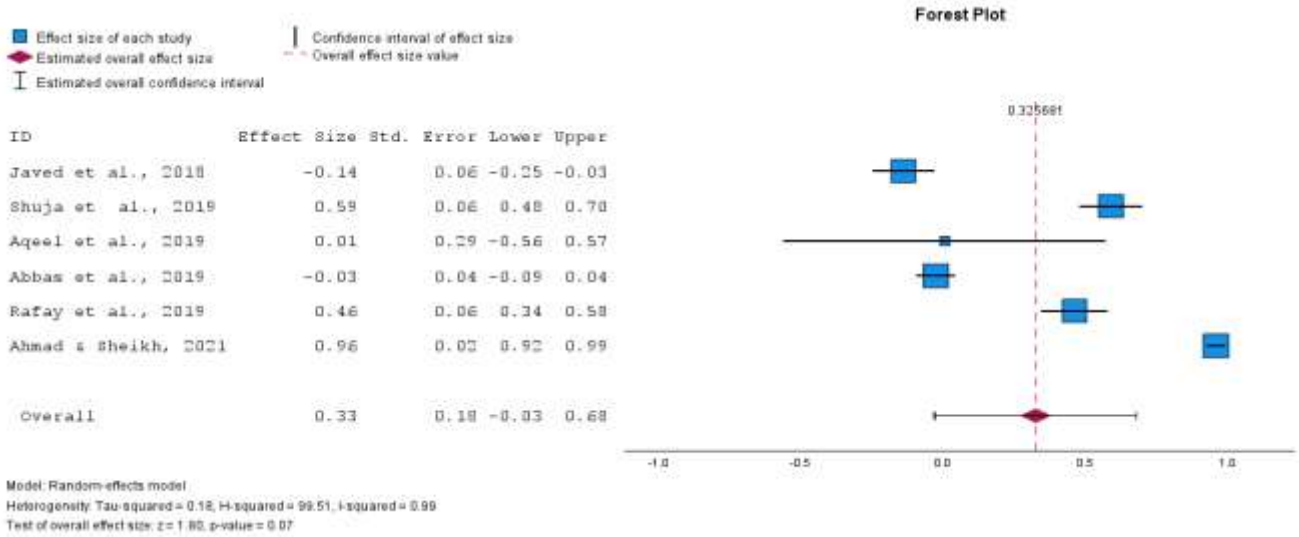
Statistical Significance: The result of the analysis was a *z*-value of 1.799 and a p-value of .072.

Interpretation: Although the finding shows the positive pattern, indicating that technology users tend to achieve better scores on the result as compared to non-users, the result is not significant at the traditional alpha level of 0.05. This shows that in the particular setting of these Pakistani universities, the use of technology in itself could not be a reliable predictor of high academic performance.

Even the individual study characteristics and the effect sizes, as well as the pooled estimate are presented with the help of a forest plot (Figure 3). The cumulative pooled effect size was calculated 0.33 (95% CI: -0.03 to 0.68). The diamond in the bottom of the plot depicts this approximate estimate. Since the 95% interval of the overall effect crosses the line of no effect (zero) the result was not taken to be significant (z=1.80, p=0.07). It was found that there was substantial heterogeneity between the included studies with an I^2 value of 99%. This means that a high percentage of the effect size variation is explained by the presence of true study to study differences and not the sampling error. The outcomes of individual studies were different: Ahmad & Sheikh (2021), Shuja et al. (2019), and Rafay et al. (2019) reported positive statistically significant results, since the confidence interval does not intersect with the null line. On the other hand, the effects centered on zero were non-significant as reported by Javed et al. (2018) and Abbas et al (2019). The interval of the negative and positive effects presented by Aqeel et al. (2019) is large and is associated with decreased precision.

Figure 3

Forest plot showing effect sizes (Hedges' g) and 95% confidence intervals for individual studies and the pooled effect



Heterogeneity Analysis

The statistics of heterogeneity show that the results of the study were varied significantly:

Q-value: 498.42 ($p < .001$)

I^2 Statistic: 99.0 %

$I^2 = 99$ is extremely large, which indicates that almost all the observed differences can be attributed to actual differences in the attributes of studies (e.g. the quality of technology applied, the field of students) as opposed to sampling error. These high levels of heterogeneity require the exploration of moderator variables to help understand the reason technology can be effective in particular settings and not in others.

Moderator Analysis

In order to examine the origin of heterogeneity, a meta-regression was conducted with Level of Education taking the role of a moderator, as indicated in Table 5.

Table 5

Moderator Analysis by Level of Education

Moderator	Coefficient	Standard Error	Z-value	p-value
Education Level	0.65	0.14	4.61	.000*

Note. indicates statistical significance at $p < .05$*

The analysis of the moderators showed that the level of education is related statistically significantly ($p < .001$) to the impact of technology. In particular, there was a much larger effect size in studies that included postgraduate students (MPhil/PhD) as opposed to studies that included undergraduate students only. It implies that digital resources are more beneficial to advanced learners who theoretically have better skills of self-regulation and research in contrast to the undergraduate students. Sample Size on the other hand, was not a strong moderator ($p=.485$) and this means that the size of the effect observed was not dependent on the size of the study cohort.

Publication Bias

The funnel plot as analyzed visually revealed a minor imbalance, but there was a blank in the lower left section. This implies that there might be an issue of a file-drawer problem, in which case small studies that found negative or null effects of technology might have been less likely

to be published. Nonetheless, since the number of studies included is small (k 6), this interpretation must be approached with a grain of salt.

Discussion

This study aimed at synthesizing empirical data on the correlation between technology integration and academic performance of Pakistani institutions of higher learning (HEIs). The pooled effect size generated by the meta-analysis was g=0.326 and p=0.72. Even though this finding is in the right direction, it does not achieve traditional levels of statistical significance. Instead of implying that educational technology is not effective, this result is the key turning point in the discussion of digital teaching-learning resources. It shows that it cannot be concluded that the existence of technology is enough to assure academic improvement but rather learning outcomes seem to be greatly conditioned by the design of digital resources and their pedagogical integration.

The Integration - Impact Gap

This overall effect is non-significant (p=.072) and corresponds to the so-called Digital Literacy Paradox of Pakistani universities (Munir et al., 2024). Their results reveal that although students usually have a good level of digital operational skills, such as smart phone and social media skills, they do not always have better academic results. Previous findings in a number of studies included under this meta-analysis (e.g., Rafay et al., 2019) also suggest that technology was often applied to deliver simple content i.e. PowerPoint slides or inactive LMS repositories and not to those activities that would allow active learning or higher-order cognitive processing. These trends lend credence to the fact that digital resources have to be purposely created and not simply implemented. Converting old instructional resources does not per se revolutionize the learning process. The lack of a structured teachers training map, which focuses on the instruction design, regularly leads to the situation where technology serves as a distraction, instead of a cognitive scaffold as highlighted by Jamil et al. (2024). To implement effective technology, a judicial balance of digital tools, pedagogical strategies and intended learning outcomes, is therefore needed.

The Moderator Effect: Level of Education does Matter

Educational level was one of the most important results of the meta-analysis because it had a moderating effect ($p < .001$).). The findings indicate that the integration of technology has significantly greater academic benefits when applied to postgraduate (MPhil/ PhD) learners compared to undergraduate (BS) learners. This difference may be viewed in the context of self-controlled learning (SRL) theory. Postgraduates tend to have greater degree of autonomy, intrinsic motivation and research competence. With access to superior digital resources, including academic databases or research and analytical tools, or collaborative research platforms, they can better utilize them to expand their knowledge and improve academic achievements (Rashid & Asghar, 2016).

Conversely, undergraduate learners are yet to acquire cognitive and metacognitive skills to guide them through open digital settings successfully. In the absence of well-designed and interactive learning designs, such learners could be more prone to adverse effects of technology use i.e. procrastination, superficial learning and distraction. This is an issue that is especially relevant when it comes to generative AI. Abbas et al. (2024) found that unmonitored use of tools like ChatGPT has a positive correlation with procrastination, and lower retention rates in academically less mature students, which leads to the conclusion about the need to provide digital learning experiences in a scaffolded mode.

Development Implications of Electronic Teaching-Learning Medium

The results of this research have a number of great implications to the design and assessment of digital teaching-learning materials in Pakistan. To begin with, the resources created by the undergraduate programs should focus on structure and direction. Digital learning environments with high structure, which involve guided learning resources, their presence in numerous formative assessments, and automated feedback systems could compensate students with less self-regulation in undergraduate education (Khan & Law, 2022).

Second, postgraduate student digital resources must be more open and loosely structured. The focus should be on the tool fluency, research connectivity, and collaborative knowledge building because postgraduate learners have already shown the ability to convert these affordances into quantifiable academic outcomes. Lastly, the outcomes emphasize the necessity of changing the metrics that focus on access to those that emphasize evaluation. Since access to technology may not necessarily lead to better performance, as indicated by the total p =.072 result, higher education institutions cannot afford to continue to rely on numbers of devices, platforms, or infrastructure. Digital resource usefulness can rather be evaluated in terms of their capacities to promote critical thinking, long-term interactions and significant learning activities.

Conclusion

This meta-analysis summarized the findings of the existing studies published since 2002 and until 2022 to assess the effect of technology integration on academic performance in Pakistani higher education. The overall effect size (g = 0.326, p =.072) indicates that the integration of technology, as it is currently implemented, can be viewed as a relatively small, but unstable, positive factor in student performance. The statistical data show that technology is not a sure remedy but the quality of its implementation in education depends on the quality of its pedagogical application. Such results contradict techno-centric notions that reduce digitalization to academic enhancement. Instead, the findings put forward a pedagogy-first approach, where instructional design is emphasized as opposed to the adoption of technology. The large heterogeneity (I^2=99) and the great degree of moderating educational level indicates a serious gap: digital technologies can be used more effectively with high level learners with good self-regulation skills, and little or variable effect on undergraduate students when there is no proper scaffolding.

With Generative AI becoming an important part of the nation as Pakistan enters a new era, the implications of this historical evidence have been especially relevant. The Digital Literacy Paradox that has always been there, with students being digitally savvy and academically unsophisticated to utilize technology in their learning processes, has to be solved before additional massive investments are made. The primary focus of future research work should be on deliberate design of learning experiences that incorporate the use of digital technologies in pedagogically significant aspects so that accessibility to technology can be transformed into real academic accomplishment.

Recommendations

Though the total impact of academic achievement on technology integration was not statistically significant (p=.072), the moderator analysis (p <.001) offers convincing proof that digital technologies offer highly beneficial effects to higher learners (MPhil/PhD) compared to undergraduates. This difference implies the necessity to consider a differentiated approach to the needs of less mature learners which should be developed taking into consideration their developmental and academic requirements. Due to these results, the subsequent recommendations are offered.

Recommendations for Policymakers (HEC and University Administration)

To begin with, further online learning programs must focus on the quality of their instructions, rather than on structural growth. Investments, like projects like the Smart Universities Project should change their preoccupation with the hardware purchase to the instructional design and curriculum development. The provision of financial support to the development of evidence-based digital learning resources should be clearly connected with the purchase of the devices or classroom technologies only. Second, the proposal to implement compulsory, credit-based academic-level courses on digital literacy among incoming undergraduates has a solid foundation. These courses must go beyond mere computer concepts to include what can be termed as digital epistemology: in what ways knowledge is sought, assessed, built and ethically applied within digitally mediated and AI-assisted spaces (Munir et al., 2024).

Third, faculty development programs must transcend the technical training sessions that are short term in nature. The development of instructional design competence and AI literacy among faculty members requires the use of a comprehensive teachers training map to be built systematically. This framework must prioritize the intelligence augmentation approaches that will allow instructors to distinguish between the pedagogically reasonable AI assistance and the practices that will revoke academic integrity (Qadir, 2023).

Suggestions for Instructional Designers and Faculty

The results of the research put a strong emphasis on the significance of the design of digital resources in different education levels. Digital resources in the case of undergraduate programs have to be extremely organized and directed. It is possible to use Learning Management Systems to develop sequenced learning paths, regular low-stakes tests, and automated feedback systems that facilitate self-control and minimize the risk of procrastination or superficial learning.

However, postgraduate learning environments should be more open and flexible in design. Such resources ought to focus on tool fluency, research connectivity, and teamwork, which should promote the successful use of reference management software, data analysis tools like SPSS and NVivo, and AI-related research platforms that can be used by postgraduate learners, who are able to engage in self-directed inquiry.

Moreover, assessment practices have to be considered with references to Generative AI. Faculty are supposed to focus more on how learning processes take place and not just focus on end products. Strategies like tracking version history, integrating verbal defenses, and evaluation of reflective or iterative work can assist in making sure that evaluations reflect real learning and not just automatic results.

Future Research Directions

A number of avenues of future research arise out of this research. It is evident that experimental and quasi-experimental designs, especially the Randomized Controlled Trials (RCTs), are needed in Pakistani higher education institutions to develop causality between the use of technology and academic performance. The majority of the existing studies are based on correlational design that restricts the ability of causal inference. Also, subsequently, studies are to differentiate between regular computer use and the particular educational effect of Generative AI tools. Disaggregating the outcomes of GenAI on outcomes including critical thinking, problem-solving, and metacognitive development will be crucial to policy informing and instructional practice in the changing digital educational environment.

References

Abbas, J., Aman, J., Nurunnabi, M., & Bano, S. (2019). The impact of social media on learning behavior for sustainable education: Evidence of students from selected universities in Pakistan. *Sustainability*, *11*(6), 1683. https://doi.org/10.3390/su11061683

Abbas, M., et al. (2024). Is it harmful or helpful? Examining the causes and consequences of generative AI usage among university students. *International Journal of Educational Technology in Higher Education*, *21*(1), Article 10. https://doi.org/10.1186/s41239-024-00444-7

Ahmad, T. and Sheikh, A. (2021) Impact of Information and Communication Technologies (ICT) on Student's Learning: A Case from University of the Punjab, Pakistan. *Digital Library Perspectives*, 38, 205-221. https://doi.org/10.1108/DLP-03-2021-0027

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. John Wiley & Sons. DOI:10.1002/9780470743386

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

Cotton, D. R., Cotton, P. A., & Shipway, J. R. (2024). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International, 61*(2), 228–239. https://doi.org/10.1080/14703297.2023.2190148

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis*. Academic Press. https://doi.org/10.1016/C2009-0-03396-0

Higher Education Commission [HEC]. (2024). *Draft framework on use of Generative AI (GenAI) tools in Higher Education Institutes (HEIs)*.

Jamil, M., Aslam, M., & Shahzad, A. (2024). Technology integration in teaching and learning: Exploring prospective teachers' perceptions, practices and challenges. *Indus Journal of Social Sciences*, 2(2), 520-529. https://doi.org/10.59075/ijss.v2i2.346

Khan, M. A., & Law, L. (2022). The struggle to reform higher education sector of Pakistan. *Journal of the Research Society of Pakistan*, *59*(2), 163–179. http://pu.edu.pk/images/journal/history/PDF-FILES/14_59_2_22.pdf

Ministry of Information Technology & Telecommunication [MOITT]. (2024). *National Artificial Intelligence Policy (Draft)*. Government of Pakistan.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Munir, H., Fatima, H., & Tufail, A. (2024). Digital literacy and students' academic performance: A study of higher education level. *Al-Mahdi Research Journal (MRJ), 5*(3), 712–726.

Ning, Y., Zhang, C., Xu, B., Zhou, Y., & Wijaya, T. T. (2024). Teachers' AI-TPACK: Exploring the relationship between knowledge elements. *Sustainability*, *16*(3), 978. https://doi.org/10.3390/su16030978

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372. https://doi.org/10.1136/bmj.n71

Qadir, J. (2023). Engineering education in the era of ChatGPT: Promise and pitfalls of generative AI for education. *2023 IEEE Global Engineering Education Conference (EDUCON)*, 1–9. https://doi.org/10.1109/EDUCON54358.2023.10125121

Rafay, A., et al. (2019). Impact of technology, satisfaction, and motivation on academic

achievement of undergraduate students. *University of Sindh Journal of Information and Communication Technology*. DOI: 10.31580/ijer.v2i4.1160

Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations. *Computers in Human Behavior*, *63*, 604–612. https://doi.org/10.1016/j.chb.2016.05.084

Shuja, A., Qureshi, I. A., Schaeffer, D. M., & Zareen, M. (2019). Effect of m-learning on students' academic performance mediated by facilitation discourse and flexibility. *Knowledge Management & E-Learning, 11*(2), 158–200. https://doi.org/10.34105/j.kmel.2019.11.009

Uzma, & Nasreen, S. (2024). Assessing the digital information literacy levels among students in higher education. *Annals of Human and Social Sciences, 5*(2), 725–737. https://doi.org/10.35484/ahss.2024(5-II-S)57