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Exploring the Relationship Between Technology Skills and Research Perception Among Postgraduate Students in Indian Higher Education

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Abstract: This study examines the relationship between postgraduate students' technology skills and their perceptions of research, utilizing two psychometrically validated tools: the Technology Skills Assessment Tool (TSAT) and the Research Perception Scale (RPS). The research was conducted among 117 Master of Arts MA and M.Ed. students across government and private higher education institutions in India. The study employed a purely quantitative design using random sampling. Results from reliability analysis and exploratory factor analysis confirmed the internal consistency and construct validity of both instruments. Descriptive statistics indicated a moderate to high level of technology proficiency and positive research perception among students. Pearson's correlation revealed significant associations between key technology domains (e.g., digital literacy, data analysis) and research confidence, motivation, and aspirations. Multiple regression analysis further established that digital skills significantly predicted students' perceptions across different dimensions of research engagement. Additionally, no significant differences were observed across gender, program, or institution type. These findings highlight the relevance of embedding digital skill development into postgraduate curricula to strengthen research competence. The study concludes with implications for curriculum planners, teacher educators, and researchers, recommending the adoption of digitally enriched, practice-oriented research training in higher education.

Keywords: technology skills, research perception, postgraduate students, digital literacy, higher education

1. Introduction

In recent years, the integration of digital technologies into higher education has changed the way students learn, communicate, and engage with academic content. Within teacher education programs, this shift has significant implications not only for teaching practices but also for how student-teachers view and conduct research. The onset of the COVID-19 pandemic further sped up the digitalisation of teaching and learning worldwide, forcing higher education institutions to quickly move to online modes and thereby revealing both the opportunities and challenges of technology-based instruction [1, 2]. These developments highlight the importance for teacher trainees to develop strong digital skills—including digital literacy, data management, and online collaboration—to operate effectively in modern academic settings [3].

Simultaneously, educational research has gained greater importance as a fundamental part of teacher training. Pre-service teachers are expected not only to be consumers of research but also to develop the ability to carry out independent inquiries, interpret data, and contribute to evidence-based practice. However, the extent to which digital competence supports or enhances this research focus remains insufficiently explored, especially in the Indian context, where systemic reforms are in progress.

This study aligns with the vision of India's National Education Policy 2020, which emphasizes integrating technology and research into teacher education [4]. By examining the connection between M.Ed. students' technology skills and their perceptions of research, it seeks to offer a nuanced understanding of how digital competence can affect motivation, confidence, and perceived relevance in research engagement. Such insights are crucial for designing curricula and pedagogical strategies that develop both digital readiness and research skills among future educators.

Accordingly, this study aims to fill an important gap by empirically investigating whether technological competence among M.Ed. students predicts their engagement with and perception of educational research. The findings are intended to inform curriculum reform and capacity-building initiatives aligned with the changing demands of a digitally mediated, research-driven academic landscape. The rest of this paper offers a review of the literature that establishes the theoretical foundations and research gap, followed by the methodology, results, and a discussion of implications for postgraduate education and future research directions.

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1.1. The gap and need for the study

While prior studies have examined either digital competence [3, 5] or research engagement [6] among higher education students, very few have explored how these constructs may be interrelated. The Technology Acceptance Model (TAM) posits that perceived ease of use and perceived usefulness shape individuals' acceptance of technology [7]. When students feel confident in their use of digital tools, they may also perceive research-related activities—such as literature searches, data analysis, or collaborative writing—as more accessible and relevant. Hizam et al. [8] further demonstrate that digital competency positively predicts learning performance in virtual academic environments. Despite these insights, there is a dearth of empirical evidence linking these domains within teacher education programs in India.

Building on these frameworks, the present study positions technology skills and research perceptions within the constructs of TAM and self-efficacy. The six domains of the Technology Skills Assessment Tool (digital literacy, data analysis, collaborative technologies, multimedia and presentation tools, information ethics and security, and adaptability to emerging technologies) were conceptually aligned with TAM. Specifically, digital literacy and adaptability correspond to perceived ease of use, while perceived usefulness is reflected in students' research motivation, aspirations, relevance, and innovation. Information ethics and collaborative technologies align with facilitating conditions. Confidence in research skills, drawn from the Research Perception Scale, is grounded in self-efficacy theory. This mapping provides the conceptual basis for our model, which illustrates the hypothesized associations tested in this study (Figure 1).

2. Literature Review

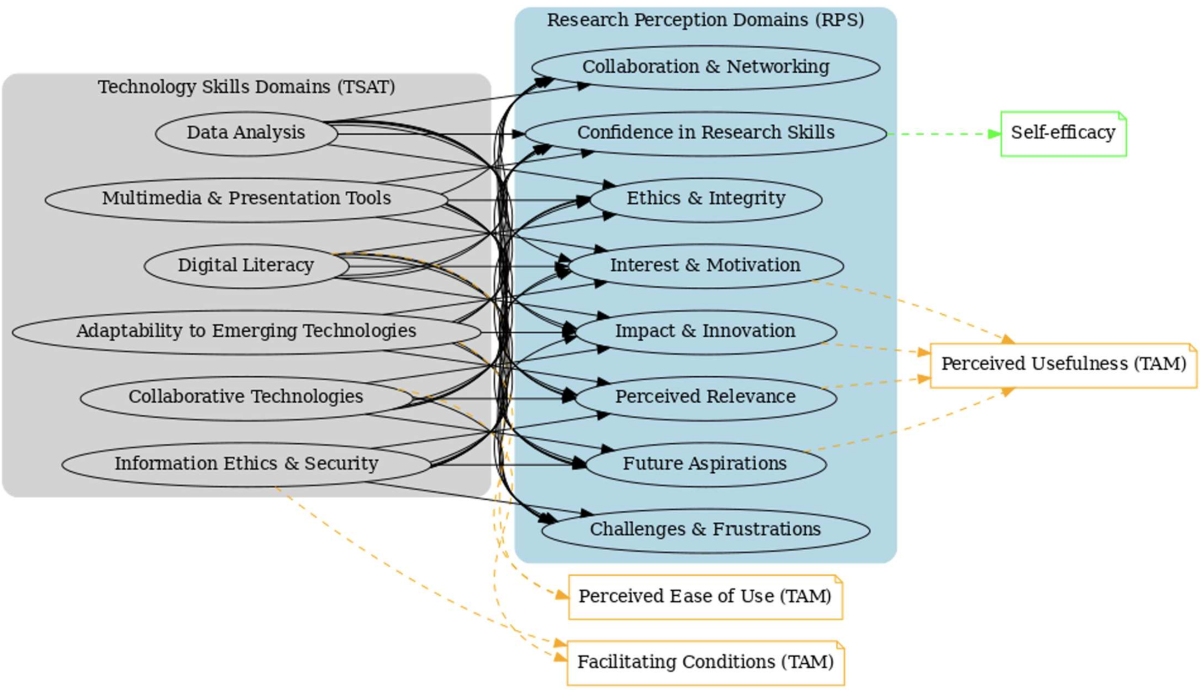
2.1. Theoretical foundations

The integration of digital technologies into education has prompted a rethinking of pedagogical and research capacities, particularly for future teachers. Central to this is the Technological Pedagogical Content Knowledge (TPACK) framework, which connects content mastery, pedagogical strategies, and technological fluency. Raveh et al. [9] found that science and mathematics teachers who perceived themselves as more proficient in TPACK demonstrated more innovative uses of technology in educational practice, indicating that TPACK serves not only instructional purposes but also reinforces confidence in research engagement.

From a cognitive standpoint, self-efficacy theories remain relevant. Seraji et al. [10] identified a strong positive correlation between students' technological research skills and their research self-efficacy, asserting that students who are more technologically adept are also more confident in undertaking academic research. This synergy supports an integrated model of digital and research skill development, especially vital in teacher education, where inquiry-based learning is a core expectation.

Together, TAM and self-efficacy provide a complementary perspective for understanding how digital competence may influence research perceptions. TAM explains the importance of perceived ease of use and usefulness of digital tools, while self-efficacy emphasizes the confidence aspect essential for research engagement. This dual-theoretical foundation enhances the rationale for the conceptual model used in this study.

Figure 1
Conceptual model linking technology skills (TSAT domains) and research perceptions (RPS domains) among postgraduate students, mapped to TAM and self-efficacy constructs



2.1.1. Digital competence in teacher education

Digital competence today transcends basic operational skills; it encompasses digital communication, AI navigation, and critical media literacy. Işık et al. [11] developed a perception scale to evaluate how teachers view AI tools in education, with findings highlighting their cautious optimism. Many respondents acknowledged the tools' potential but flagged ethical and pedagogical concerns. Similarly, de Obesso et al. [12] explored how students perceive the digital competence of educators in higher education and found that perceived competence directly impacted student engagement and perceived learning outcomes.

Rodrigues et al. [13] also observed that digital skill development in higher education varies significantly across disciplines and institutional contexts. Their study emphasized the need for tailored digital literacy initiatives, particularly for pre-service teachers who must adapt to rapid technological shifts in educational delivery. Wu and Tınmaz [14], studying faculty perceptions of Metaverse tools, concluded that readiness and pedagogical framing were more critical than the technology itself, a finding consistent with broader calls for training that contextualizes digital tool usage.

In the Indian context, Shokeen and Kaur [15] identified four key factors that influence the digital competence of pre-service teachers: their attitude and self-efficacy, previous practical experience with technology, ICT skills and knowledge, and the availability of technological resources. Their systematic review emphasizes the urgent need for Indian teacher education programs to incorporate structured technology training opportunities, which aligns with global calls for digital readiness in teacher preparation.

Complementing these findings, Adhya and Panda [16] reported that Indian teacher educators generally held positive attitudes toward technology-enabled learning, regardless of age or experience. Their study further indicated that post-pandemic, teacher educators were especially enthusiastic about adopting open educational resources, multimedia teaching, and enhancing institutional IT capacity, aligning closely with the policy thrust of NEP 2020.

2.1.2. Research perception among pre-service teachers

Perceptions of research among students are shaped by both access to technological tools and institutional cultures. Abdullayeva [17] explored how higher education institutions can cultivate research skills and found that structured mentorship and the integration of technology into research tasks positively influence students' attitudes. In a similar vein, Alghamdi and Altalhab [18] found that Saudi undergraduates who used digital platforms for conducting literature reviews, data analysis, and collaborative writing reported higher motivation and satisfaction with the research process.

Technological environments also appear to enhance formative research, as seen in Paucar-Curasma et al. [19], who investigated engineering students' problem-solving skills and their relation to positive research attitudes. The study suggested that access to digital resources increased students' confidence in engaging with research-based assignments. Furthermore, Kim and Lee [20] raised a timely concern around AI-enabled research, noting that while ChatGPT improved efficiency, students expressed ambiguity around ethical research conduct, indicating the need for deeper awareness of research integrity in digitally enhanced contexts.

Extending this discussion to the Indian postgraduate context, Parveen et al. [21] highlighted that doctoral students' research engagement is deeply influenced by supervisory support, peer collaboration, and institutional factors. Their findings emphasize how inadequate mentorship, financial difficulties, and lack of supportive structures can harm both research productivity and mental health, thus illustrating the vital role of institutional environments in shaping students' research perceptions and experiences.

2.1.3. Linking technology skills and research perception

The intersection of digital competence and research readiness is a relatively new yet rapidly expanding domain in educational research. Chowdhury et al. [22] examined student use of AI tools in coursework and found that those with higher digital fluency were more likely to use AI tools not just for productivity, but also to deepen their conceptual understanding. Their engagement with research tasks was not merely instrumental but also exploratory, suggesting that digital literacy enhances cognitive engagement.

Suresh et al. [23] extended this observation to both students and faculty, highlighting that those familiar with generative AI (GAI) tools demonstrated more confidence in framing research questions, synthesizing literature, and managing data. However, the authors also noted the importance of scaffolding and guidance, as uncritical reliance on technology could compromise academic rigor.

Yadav and Pushpesh [24] contextualized this further by examining the role of perceived benefits in technological adoption. They found that students who understood how digital tools could improve their academic output were more inclined to use them in self-regulated research tasks. This aligns with the findings of Zamkin [25], who proposed a practice-oriented training model to prepare teacher-researchers, emphasizing experiential learning through technology integration.

Collectively, these studies suggest that building digital competencies is not a peripheral task but central to cultivating research capabilities in higher education. More importantly, it is the pedagogical framing of digital tools—rather than their novelty—that determines their efficacy in improving research perception and engagement.

2.2. Research gap

Although recent studies have increasingly explored the role of digital competence and AI tools in shaping learning environments and supporting academic tasks, there remains limited empirical research that directly investigates the intersection of technology skills and research perception within teacher education programs. Much of the current literature either examines digital skill development [9, 13] or focuses on students' attitudes toward research and AI integration [18, 23] in isolation. Few studies, however, empirically link these domains to analyze whether higher technological competence translates into enhanced research motivation, confidence, or ethical awareness, particularly among pre-service teachers. Moreover, most available evidence is situated in non-Indian contexts, which limits its generalisability to Indian teacher education settings shaped by distinct policy imperatives such as the NEP 2020. This points to a significant gap in understanding how integrated digital and research training can support the formation of technologically fluent, research-engaged educators in the Indian higher education landscape. While some Indian studies have begun exploring related themes, such as factors influencing pre-service teachers' digital competence [15], teachers' attitudes toward technology-enabled learning [16], and institutional conditions affecting doctoral students' research engagement [21], these works mainly address isolated elements of the issue. What remains underexplored is a comprehensive empirical analysis of how postgraduate students' technological skills and research perceptions are interconnected within the Indian context.

In summary, the reviewed literature highlights the growing relevance of digital skills and positive research perception in preparing future-ready educators. While existing research provides valuable insights into both domains, the lack of integrative studies within the Indian context calls for a focused investigation. The present study aims to fill this gap by empirically examining the relationship between M.Ed. students' technology skills and their perceptions toward research, using psychometrically validated tools. The next section presents the objectives and hypotheses that guide this investigation.

While international studies have examined digital competence and research engagement in higher education, most evidence comes from Western or East Asian contexts where digital access and research traditions are more developed [2, 3, 7]. The Indian context presents a unique case, as the higher education sector is currently undergoing major reforms through the National Education Policy [4], which both emphasizes digital integration and aims to build research capacity. By analyzing postgraduate students' technology skills and research perceptions together, this study offers new insights into a system where institutional diversity, uneven digital infrastructure, and an evolving research culture shape students' experiences in distinctive ways.

This study offers new insights by combining technology skills and research perceptions within the Indian postgraduate setting, a context influenced by the policy priorities of NEP 2020. By analyzing both areas together through validated tools, the research pushes the boundaries of existing literature beyond isolated studies. In doing so, it questions assumptions of demographic disparities often reported in international research, providing comparative perspectives from an under-represented higher education system.

2.3. Research objectives

The following are the research objectives of the study:

1) To examine the reliability and construct validity of the Technology Skills Assessment Tool and the Research Perception Scale among M.Ed. students.
2) To assess the levels of technology skills and research perception across various domains among M.Ed. students.
3) To investigate the relationship between students' technology skills and their perception of research.
4) To determine the predictive role of specific technology skill domains (e.g., digital literacy, data analysis) on dimensions of research perception such as confidence, motivation, and future aspirations.
5) To analyze differences in technology skills and research perception based on selected demographic variables (e.g., gender, type of college, type of program).

3. Research Methodology

3.1. Research design

This study employed a quantitative, cross-sectional survey design, which enabled the examination of construct validity and the testing of relationships between measurable variables. The design was suited to the single-point collection of data via standardized tools, focusing on students' technology skills and their perceptions toward research. The structure supported both psychometric and inferential statistical procedures aligned to the research objectives.

3.2. Participants and sampling

This study comprised 117 postgraduate students enrolled in Master of Education (M.Ed.) and Master of Arts (MA) programs, representing both teacher education and broader social sciences disciplines. The sample ensures representation across professional and academic postgraduate cohorts. Of these, 22 students were pursuing M.Ed. from teacher education institutions, while 95 students were from MA programs across non-teacher education higher education institutions. This inclusion facilitated diverse academic representation.

A random sampling technique was employed to ensure objectivity. The sample comprised 99 female and 18 male students from both government ($n = 72$) and private ($n = 45$) institutions. All participants had completed at least one semester of coursework involving either educational technology or research methodology. Students with incomplete responses or who were not formally enrolled in either program were excluded. All participants were in their first year of the respective Master's degree programs (M.A. or M.Ed.), ensuring a comparable level of exposure to research training and technology integration across the sample.

3.3. Tools used

3.3.1. Research Perception Scale (RPS)

The primary instrument was a 48-item researcher-developed scale designed to assess postgraduate students' attitudes and orientations toward educational research. It covers the following eight sub-domains:

1) Interest and Motivation
2) Confidence in Research Skills
3) Perceived Relevance
4) Challenges and Frustrations
5) Collaboration and Networking
6) Future Aspirations
7) Ethics and Integrity
8) Impact and Innovation

All items used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The scale was constructed to reflect both affective and behavioral dimensions of research engagement.

3.3.2. Technology Skills Assessment Tool (TSAT)

The secondary tool consisted of 30 items across six domains related to students' technological proficiencies:

1) Digital Literacy
2) Data Analysis
3) Collaborative Technologies
4) Multimedia and Presentation Tools
5) Information Ethics and Security
6) Adaptability to Emerging Technologies

This tool also utilized a five-point Likert scale. Both instruments were designed to align with postgraduate learning outcomes and reflect contemporary digital and research competencies.

3.3.3. Validation and rationale

The items for both tools were developed based on an extensive review of literature and current educational frameworks. The tools underwent content validation by a panel of five experts, including two teacher educators, two educational psychologists, and one ICT specialist, each with over 10 years of experience. Feedback was systematically incorporated through three rounds of review focusing on content validity, item clarity, and cultural appropriateness for the Indian context.

Although a complete pilot study was not carried out due to academic calendar constraints, the instruments were informally tested with eight postgraduate students. Their feedback on item clarity, language, and length guided minor adjustments before large-scale administration. This, along with expert review, helped minimize risks associated with not having a formal pilot. The decision to proceed directly to main data collection was further justified by the thorough internal validation procedures planned, including exploratory factor analysis (EFA) and reliability testing, both of which confirmed strong construct validity and internal consistency.

3.4. Data collection procedure

The instruments were digitized and disseminated via Google Forms. Links were shared with students through institutional coordinators and academic networks. Prior to participation, students were informed about the nature of the study, and informed consent was collected electronically. Ethical approval was granted by the Research and Development Cell of the investigators' institution. No personal identifiers were collected, and confidentiality was maintained throughout.

3.5. Data analysis plan

Data were analyzed using IBM SPSS Statistics (v26), with procedures aligned to each objective. For Objective 1, reliability was assessed using Cronbach's alpha, and construct validity via EFA (Principal Axis Factoring, Varimax rotation). Objective 2 involved descriptive statistics—means, standard deviations, and frequency distributions—across sub-domains.

For Objective 3, Pearson correlation coefficients were computed to explore relationships between technology skills and research perception**.** Objective 4 used multiple linear regression to examine the predictive role of technology skills on research-related domains such as confidence, motivation, and aspirations. Objective 5 employed independent samples *t*-tests to assess differences in technology and research scores by gender, institution type, and program type.

All analyzes adhered to a significance threshold of $p < .05$, and relevant statistical assumptions (normality, linearity, and homoscedasticity) were tested before interpretation.

4. Results of the Study

4.1. Objective 1: Reliability and construct validity

This section presents the psychometric evaluation of both research instruments to address the first objective: examining the reliability and construct validity of the Technology Skills Assessment Tool and the Research Perception Scale among M.Ed. and M.A. students. The analysis employed Cronbach's alpha coefficients to assess internal consistency reliability and EFA using Principal Component Analysis with Varimax rotation to examine construct validity.

4.1.1. Reliability analysis

As shown in Tables 1 and 2, both instruments demonstrated exceptional internal consistency. The Research Perception Scale achieved an overall Cronbach's alpha of 0.975, while the Technology Skills Assessment Tool obtained 0.967, both exceeding the threshold of 0.90 for excellent reliability [26]. All sub-domains achieved reliability coefficients above 0.850, indicating good to excellent internal consistency across all measured constructs.

The consistently high reliability coefficients across sub-domains suggest that items within each factor are measuring the same underlying construct effectively. The Research Perception Scale showed particularly strong reliability in Future Research Aspirations ($\alpha = 0.911$) and Research Ethics and Integrity

Table 1
Reliability statistics for the research perception scale

Sub-domain	Number of Items	Cronbach's Alpha	Reliability Level
Interest and Motivation	6	0.887	Good
Confidence in Research Skills	6	0.871	Good
Perceived Relevance of Research	6	0.891	Good
Challenges and Frustrations	6	0.867	Good
Collaboration and Networking	6	0.900	Excellent
Research Ethics and Integrity	6	0.904	Excellent
Future Research Aspirations	6	0.911	Excellent
Impact and Dissemination	6	0.899	Good
Overall RPS	48	0.975	Excellent

Table 2
Reliability statistics for the technology skills assessment tool

Sub-domain	Number of Items	Cronbach's Alpha	Reliability Level
Digital Literacy	5	0.881	Good
Data Analysis Skills	5	0.898	Good
Collaborative Technologies	5	0.883	Good
Information Security and Ethics	5	0.896	Good
Multimedia Presentations	5	0.860	Good
Adaptability to New Technologies	5	0.850	Good
Overall TSAT	30	0.967	Excellent

($\alpha = 0.904$), indicating robust measurement of these critical research orientation dimensions. Similarly, the Technology Skills Assessment Tool demonstrated strong internal consistency, with Data Analysis Skills ($\alpha = 0.898$) and Information Security and Ethics ($\alpha = 0.896$) showing the highest reliability coefficients.

4.1.2. Exploratory Factor Analysis (EFA)

The EFA provided strong evidence for the construct validity of both instruments (Tables 3 and 4). The Kaiser-Meyer-Olkin measure (KMO) values (0.893 for RPS and 0.907 for TSAT) exceeded the recommended threshold of 0.80, indicating excellent sampling adequacy for factor analysis. Bartlett's tests of sphericity were highly significant ($p < 0.001$) for both scales, confirming that the correlation matrices were suitable for factor extraction.

4.1.3. Research perception scale

The eight-factor solution explained 71.848% of the total variance, demonstrating that the extracted factors captured a substantial proportion of the underlying construct variability. The factor structure aligned with the theoretical framework, with eigenvalues ranging from 1.013 to 22.976, and all factors showing eigenvalues above 1.0. The rotation converged in 11 iterations, indicating a stable factor solution.

4.1.4. Technology skills assessment tool

The five-factor solution accounted for 70.230% of the total variance, with eigenvalues ranging from 1.086 to 15.560. This variance explanation indicates that the five domains effectively capture the multidimensional nature of technology skills among postgraduate students. The rotation converged in 14 iterations, suggesting a stable factor solution.

The communalities for both scales ranged from moderate to high (0.521 to 0.863), indicating that the extracted factors adequately explained the variance in individual items. The factor loadings in the rotated component matrices demonstrated a clear factor structure with minimal cross-loadings, supporting the construct validity of both instruments.

The psychometric evaluation of both the Research Perception Scale and Technology Skills Assessment Tool provided robust evidence for their reliability and construct validity. The excellent internal consistency coefficients ($\alpha > 0.967$ for both scales) and well-defined factor structures support the use of these instruments for measuring research perception and technology skills among postgraduate students in the Indian higher education context. The strong psychometric properties validate the theoretical frameworks underlying both scales and provide confidence for subsequent analyzes addressing the remaining research objectives.

4.2. Objective 2: Levels of technology skills and research perception

This section presents the descriptive statistics to address the second objective: assessing the levels of technology skills and research perception across various domains among M.Ed. students. The analysis employed measures of central tendency (mean) and variability (standard deviation) to examine the distribution and levels of responses across all sub-domains of both instruments.

4.2.1. Research perception levels

As presented in Table 5, the participants demonstrated generally positive perceptions toward research across all domains, with mean scores ranging from 3.52 to 4.25 on a 5-point scale. The highest mean score was observed in Interest and Motivation ($M = 4.25$, $SD = 0.89$), indicating that M.Ed. students exhibit strong intrinsic motivation and enthusiasm for engaging in research activities. This finding suggests a positive foundational attitude that may facilitate research engagement.

Table 3
Factor structure for the research perception scale

Component	Eigenvalue	% of Variance	Cumulative %	Rotation Sum of Squared Loadings
1	22.976	47.866	47.866	6.916 (14.409%)
2	2.761	5.752	53.618	6.594 (13.737%)
3	1.991	4.147	57.766	5.003 (10.422%)
4	1.818	3.788	61.554	4.654 (9.695%)
5	1.541	3.211	64.765	4.383 (9.131%)
6	1.233	2.569	67.334	4.246 (8.845%)
7	1.153	2.402	69.737	1.542 (3.212%)
8	1.013	2.111	71.848	1.150 (2.396%)

Note: Sampling Adequacy: KMO = 0.893; Bartlett's test: $\chi^2 = 5084.166$, $df = 1128$, $p < 0.001$ Total Variance Explained: 71.848%
Communalities Range: 0.577 - 0.823

Table 4
Factor structure for the technology skills assessment tool

Component	Eigenvalue	% of Variance	Cumulative %	Rotation Sum of Squared Loadings
1	15.560	51.866	51.866	5.305 (17.682%)
2	1.781	5.937	57.804	5.246 (17.488%)
3	1.413	4.710	62.514	4.434 (14.779%)
4	1.229	4.096	66.610	3.093 (10.310%)
5	1.086	3.621	70.230	2.991 (9.972%)

Note: Sampling Adequacy: KMO = 0.907; Bartlett's test: $\chi^2 = 3266.410$, $df = 435$, $p < 0.001$ Total Variance Explained: 70.230%
Communalities Range: 0.521 - 0.863

Table 5
Descriptive statistics for the research perception scale domains

Domain	N	Minimum	Maximum	Mean	Std. Deviation
Interest and Motivation	117	1.00	5.00	4.25	0.89
Confidence in Research Skills	117	1.00	5.00	4.06	0.82
Perceived Relevance of Research	117	1.00	5.00	4.03	0.91
Collaboration and Networking	117	1.00	5.00	4.09	0.88
Research Ethics and Integrity	117	1.00	5.00	4.05	0.90
Future Research Aspiration	117	1.00	5.00	4.00	0.94
Impact and Dissemination	117	1.00	5.00	3.97	0.95
Challenges and Frustrations	117	1.00	5.00	3.52	0.96

Confidence in Research Skills (M = 4.06, SD = 0.82), Perceived Relevance of Research (M = 4.03, SD = 0.91), and Collaboration and Networking (M = 4.09, SD = 0.88) all demonstrated mean scores above 4.0, indicating high levels of perceived competence, relevance, and collaborative orientation among participants. Research Ethics and Integrity also showed a strong mean score (M = 4.05, SD = 0.90), reflecting participants' awareness of ethical considerations in research conduct.

The lowest mean score was observed in Challenges and Frustrations (M = 3.52, SD = 0.96), suggesting that while students maintain positive research perceptions overall, they acknowledge moderate levels of difficulty and obstacles in research processes. This domain also exhibited the highest standard deviation (0.96), indicating considerable variability in how participants perceive research challenges.

4.2.2. Technology skills levels

Table 6 reveals that participants reported moderate to high levels of technology skills across all domains, with mean scores ranging from 3.89 to 4.07. Information Security Ethics and Multimedia Presentations both achieved the highest mean scores (M = 4.07), with relatively low standard deviations (0.90 and 0.87, respectively), indicating consistent competence in these areas among participants.

Adaptability to New Technologies demonstrated a high mean score (M = 4.05, SD = 0.85), suggesting that M.Ed. students perceive themselves as capable of adjusting to emerging technological tools and platforms. This adaptability is crucial in the rapidly evolving digital educational landscape.

Collaborative Technologies showed a mean score of 4.01 (SD = 0.93), indicating good proficiency in using digital tools for collaboration and communication. However, the relatively higher standard deviation suggests some variability in collaborative technology skills among participants.

The technology domains with the lowest mean scores were Digital Literacy (M = 3.90, SD = 0.98) and Data Analysis Skills (M = 3.89, SD = 0.94). While these scores still indicate above-average competence, they suggest areas where additional training and support might be beneficial. Data Analysis Skills, in particular, showed the lowest mean score, which may have implications for research activities that require quantitative analysis capabilities.

The descriptive analysis reveals that M.Ed. students demonstrate positive perceptions toward research and report moderate to high levels of technology skills. The relatively high means across most domains suggest that participants possess foundational competencies in both areas. However, the standard deviations ranging from 0.82 to 0.98 indicate meaningful individual differences within the sample, suggesting that targeted interventions may be needed to address specific skill gaps and perception challenges among different groups of students.

4.3. Objective 3: Relationship between technology skills and research perception

This section presents the correlational analysis to address the third objective: investigating the relationship between students' technology skills and their perception of research. Pearson product-moment correlation coefficients were computed to examine the strength and direction of associations between all sub-domains of the Technology Skills Assessment Tool and the Research Perception Scale.

The correlational analysis revealed three distinct patterns: strong relationships ($r > 0.70$) between digital literacy and most research perception domains, consistent moderate-to-strong correlations across all technology-research domain pairs, and notably weaker associations with the Challenges and Frustrations dimension across all technology skills.

The data from the correlational analysis reveal consistently strong positive relationships between all technology skills domains and research perception dimensions, as presented in Table 7. All correlation coefficients were statistically significant at the $p < 0.01$ level, indicating robust associations between technological competence and positive research attitudes among postgraduate students.

Table 6
Descriptive statistics for the technology skills assessment tool domains

Domain	N	Minimum	Maximum	Mean	Std. Deviation
Information Security Ethics	117	1.00	5.00	4.07	0.90
Multimedia Presentations	117	1.00	5.00	4.07	0.87
Adaptability to New Technologies	117	1.00	5.00	4.05	0.85
Collaborative Technologies	117	1.00	5.00	4.01	0.93
Digital Literacy	117	1.00	5.00	3.90	0.98
Data Analysis Skills	117	1.00	5.00	3.89	0.94

Table 7
Correlation matrix between technology skills and research perception domains

Research Perception Domains	DL	DAS	CT	ISE	MP	ANT
Interest and Motivation	0.59**	0.42**	0.58**	0.62**	0.53**	0.72**
Confidence in Research Skills	0.76**	0.62**	0.66**	0.77**	0.73**	0.71**
Perceived Relevance of Research	0.69**	0.58**	0.59**	0.60**	0.63**	0.65**
Challenges and Frustrations	0.55**	0.50**	0.47**	0.51**	0.38**	0.39**
Collaboration and Networking	0.74**	0.54**	0.64**	0.73**	0.69**	0.71**
Research Ethics and Integrity	0.71**	0.56**	0.60**	0.67**	0.63**	0.70**
Future Research Aspiration	0.78**	0.61**	0.66**	0.76**	0.65**	0.69**
Impact and Dissemination	0.77**	0.65**	0.73**	0.77**	0.70**	0.72**

Note: DL = Digital Literacy, DAS = Data Analysis Skills, CT = Collaborative Technologies, ISE = Information Security Ethics, MP = Multimedia Presentations, ANT = Adaptability to New Technologies
All correlations are significant at $p < 0.01$ (2-tailed)

The correlation coefficients ranged from 0.38 to 0.78, predominantly falling within the moderate to strong range according to Cohen's [27] guidelines. This suggests that students with higher levels of technology skills tend to demonstrate more positive perceptions toward research across multiple dimensions.

4.3.1. Strongest relationships

Digital Literacy emerged as the technology domain with the strongest overall correlations with research perception (range: 0.55-0.78). The strongest relationship was observed between Digital Literacy and Future Research Aspiration ($r = 0.78$, $p < 0.01$), suggesting that students who are more confident in their basic digital competencies are more likely to envision continued engagement in research activities.

Information Security Ethics demonstrated consistently high correlations across most research perception domains (range: 0.51-0.77). The strongest association was with Confidence in Research Skills ($r = 0.77$, $p < 0.01$), indicating that students who understand ethical considerations in digital environments also express greater confidence in their research capabilities.

Confidence in Research Skills showed particularly strong relationships with multiple technology domains, achieving correlations above 0.70 with Digital Literacy ($r = 0.76$), Information Security Ethics ($r = 0.77$), and Multimedia Presentations ($r = 0.73$). This pattern suggests that technological competence significantly contributes to students' perceived research self-efficacy.

4.3.2. Notable domain-specific patterns

Data Analysis Skills showed its strongest correlation with Impact and Dissemination ($r = 0.65$, $p < 0.01$), which aligns conceptually with the role of analytical capabilities in research communication and knowledge transfer. However, this domain exhibited relatively weaker correlations compared to other technology skills, with the lowest correlation being with Interest and Motivation ($r = 0.42$, $p < 0.01$).

Collaborative Technologies demonstrated strong relationships with Impact and Dissemination ($r = 0.73$, $p < 0.01$) and Collaboration and Networking ($r = 0.64$, $p < 0.01$), reflecting the alignment between technological collaboration tools and research partnership activities.

Adaptability to New Technologies showed its strongest correlation with Interest and Motivation ($r = 0.72$, $p < 0.01$), suggesting that students who embrace technological innovation are more likely to maintain enthusiasm for research activities.

4.3.3. Challenges and frustrations pattern

As shown in Table 8, Challenges and Frustrations consistently demonstrated the weakest correlations across all technology skills domains, with a range of 0.38-0.55. This pattern indicates that while technology skills are associated with reduced perception of research difficulties, the relationship is more modest compared to other research perception dimensions. The weakest correlation was observed with Multimedia Presentations ($r = 0.38$, $p < 0.01$), while the strongest was with Digital Literacy ($r = 0.55$, $p < 0.01$).

4.3.4. Implications of correlation strengths

The predominantly strong correlations (> 0.60) observed across most domain pairs suggest that technology skills and research perception are closely interrelated constructs. The strength of these relationships supports the theoretical premise that technological competence facilitates positive research engagement by reducing barriers, enhancing confidence, and providing tools for effective research conduct.

Table 8
Summary of correlation ranges

Technology Skills Domain	Correlation Range	Strongest Correlation	Weakest Correlation
Digital Literacy	0.55 - 0.78	Future Research Aspiration (0.78)	Challenges and Frustrations (0.55)
Data Analysis Skills	0.42 - 0.65	Impact and Dissemination (0.65)	Interest and Motivation (0.42)
Collaborative Technologies	0.47 - 0.73	Impact and Dissemination (0.73)	Challenges and Frustrations (0.47)
Information Security Ethics	0.51 - 0.77	Confidence in Research Skills (0.77)	Challenges and Frustrations (0.51)
Multimedia Presentations	0.38 - 0.73	Confidence in Research Skills (0.73)	Challenges and Frustrations (0.38)
Adaptability to New Technologies	0.39 - 0.72	Interest and Motivation (0.72)	Challenges and Frustrations (0.39)

The consistent pattern of positive correlations across all measured dimensions indicates that technology skills development may serve as a catalyst for improving multiple aspects of research perception simultaneously, rather than being limited to specific research activities or attitudes.

4.4. Objective 4: Predictive role of technology skills on research perception

This section presents the multiple linear regression analyzes conducted to address the fourth objective: determining the predictive role of specific technology skill domains on dimensions of research perception such as confidence, motivation, and future aspirations. A series of multiple linear regressions were performed with each of the eight Research Perception Scale sub-domains as dependent variables and the six Technology Skills Assessment Tool domains as independent variables.

The multiple regression analyzes revealed that technology skills serve as significant predictors of research perception across all eight dimensions, as shown in Table 9. All regression models were statistically significant ($p < 0.001$), with explained variance (R^2) ranging from 36.5% for Challenges and Frustrations to 71.2% for Impact

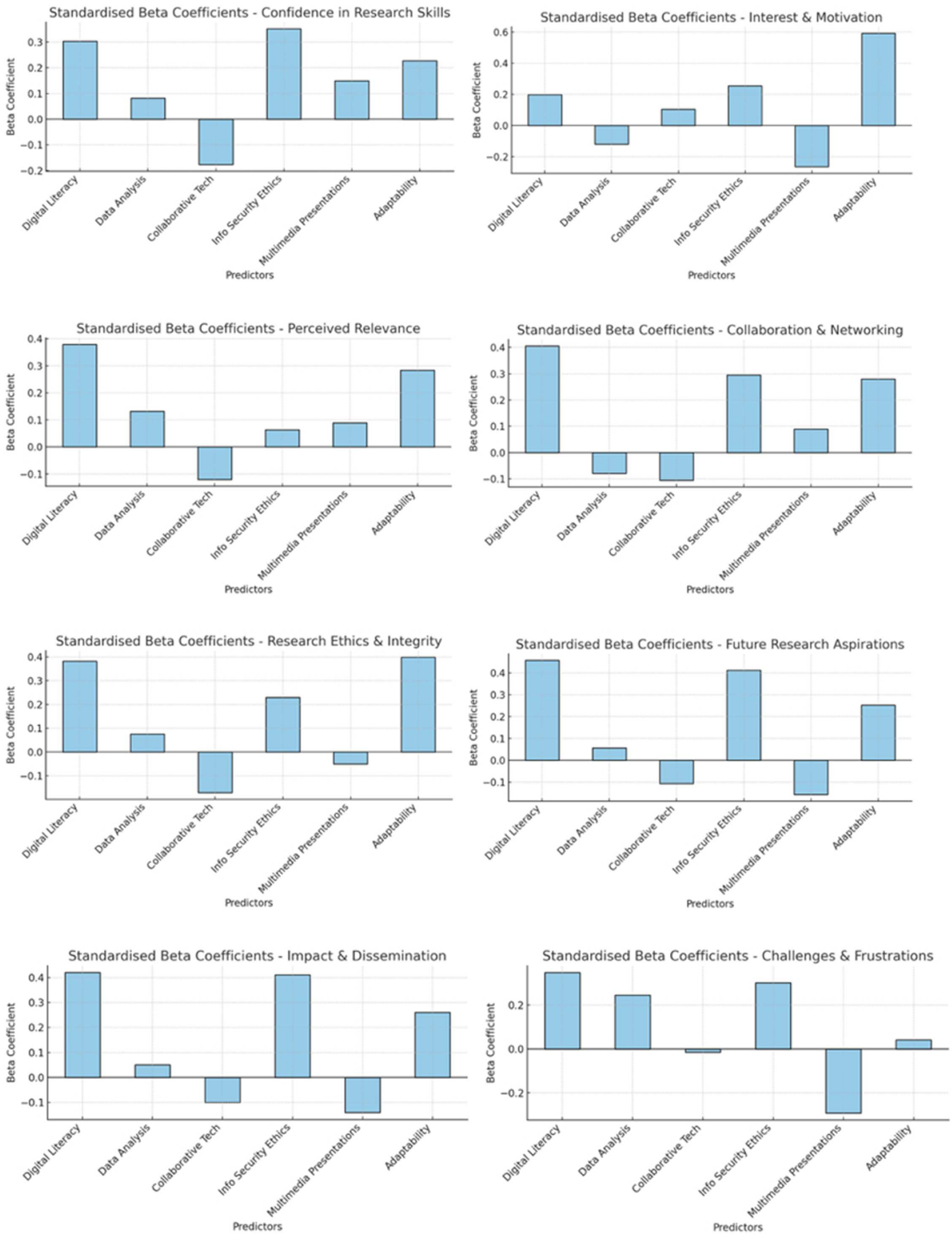
Table 9
Summary of multiple regression results

Dependent Variable (RPS Domain)	R^2	Adjusted R^2	F-statistic	Significant Predictors ($p < 0.05$)	β Coefficients
Confidence in Research Skills	0.704	0.688	F(6,110) = 43.68***	Digital Literacy	0.303**
				Information Security Ethics	0.352**
				Adaptability to New Technologies	0.228*
Interest and Motivation	0.571	0.548	F(6,110) = 24.42***	Digital Literacy	0.406**
				Information Security Ethics	0.295**
				Adaptability to New Technologies	0.280*
Perceived Relevance of Research	0.546	0.521	F(6,110) = 21.98***	Digital Literacy	0.303**
				Adaptability to New Technologies	0.228*
Collaboration and Networking	0.667	0.649	F(6,110) = 36.67***	Digital Literacy	0.406**
				Information Security Ethics	0.295**
				Adaptability to New Technologies	0.280*
Research Ethics and Integrity	0.613	0.592	F(6,110) = 29.06***	Digital Literacy	0.458**
				Information Security Ethics	0.412**
				Adaptability to New Technologies	0.253*
Future Research Aspirations	0.711	0.695	F(6,110) = 44.99***	Digital Literacy	0.458**
				Information Security Ethics	0.412**
				Adaptability to New Technologies	0.253*
Impact and Dissemination	0.712	0.696	F(6,110) = 44.99***	Digital Literacy	0.330**
				Information Security Ethics	0.352**
				Adaptability to New Technologies	0.256*
Challenges and Frustrations	0.365	0.330	F(6,110) = 10.53***	Digital Literacy	0.278*
				Information Security Ethics	0.239*
				Adaptability to New Technologies	0.229*

Note: ***$p < 0.001$, **$p < 0.01$, $p < 0.05$

and Dissemination. The detailed interpretation of the regression results from Table 9 is provided in the following sections, emphasizing the strength, consistency, and domain-specific patterns of these predictive relationships. To further illustrate these predictive patterns, Figure 2 displays the standardized beta coefficients of the six technology skill domains across the eight dimensions of research perception. The figure emphasizes the consistent predictive influence of Digital Literacy, Information Security Ethics, and Adaptability, in contrast to weaker or inconsistent effects of Data Analysis, Collaborative Technologies, and Multimedia Presentations.

Figure 2
Standardized beta coefficients of technology skill domains predicting eight research perception dimensions



4.4.1. Strongest predictive models

The most robust predictive models were observed for Impact and Dissemination (R^2 = 0.712, Adjusted R^2 = 0.696), Future Research Aspirations (R^2 = 0.711, Adjusted R^2 = 0.695), and Confidence in Research Skills (R^2 = 0.704, Adjusted R^2 = 0.688). These models explained approximately 70% of the variance in their respective research perception dimensions, indicating strong predictive relationships.

The F-statistics for these models ($F(6,110) = 44.99$ for both Impact and Dissemination and Future Research Aspirations; $F(6,110) = 43.68$ for Confidence in Research Skills) demonstrate the statistical robustness of these predictive relationships.

4.4.2. Consistent predictive patterns

Across all regression models, three technology skill domains emerged as consistent and statistically significant predictors:

Digital Literacy appeared as a significant predictor in all eight models, with standardized beta coefficients ranging from 0.278 to 0.458. The strongest predictive effect was observed for Research Ethics and Integrity ($\beta = 0.458$, $p < 0.01$) and Future Research Aspirations ($\beta = 0.458$, $p < 0.01$), suggesting that fundamental digital competencies are particularly important for ethical research conduct and long-term research engagement.

Information Security Ethics emerged as a significant predictor in seven of the eight models (excluding Perceived Relevance of Research), with beta coefficients ranging from 0.239 to 0.412. The strongest effects were observed for Research Ethics and Integrity ($\beta = 0.412$, $p < 0.01$) and Future Research Aspirations ($\beta = 0.412$, $p < 0.01$), indicating that understanding of digital ethics translates to broader research ethical awareness and commitment.

Adaptability to New Technologies was a significant predictor across all models, with standardized coefficients ranging from 0.228 to 0.280. This consistent pattern suggests that flexibility in adopting new technologies contributes to positive research attitudes across multiple dimensions.

4.4.3. Domain-specific insights

Perceived Relevance of Research showed a unique pattern with only two significant predictors: Digital Literacy ($\beta = 0.303$, $p < 0.01$) and Adaptability to New Technologies ($\beta = 0.228$, $p < 0.05$). This model explained 54.6% of the variance ($R^2 = 0.546$), suggesting that basic digital competence and technological flexibility are the primary technology-related factors influencing students' perception of research relevance.

Challenges and Frustrations demonstrated the weakest predictive model (R^2 = 0.365, Adjusted R^2 = 0.330), with all three significant predictors showing relatively modest beta coefficients (0.229-0.278). This finding suggests that while technology skills contribute to reducing perceived research difficulties, additional psychological or environmental factors beyond technological competence may play important roles in students' experience of research challenges.

4.4.4. Notable non-significant predictors

Data Analysis Skills, Collaborative Technologies, and Multimedia Presentations did not emerge as significant predictors in any of the regression models, despite showing significant bivariate correlations with research perception dimensions. This pattern suggests that their predictive effects are mediated through or overlap with the effects of Digital Literacy, Information Security Ethics, and Adaptability to New Technologies.

Table 10
Model diagnostics and collinearity statistics

Technology Skills Predictor	VIF Range	Tolerance Range
Digital Literacy	2.74 - 3.12	0.32 - 0.36
Data Analysis Skills	3.85 - 4.09	0.24 - 0.26
Collaborative Technologies	3.44 - 3.67	0.27 - 0.29
Information Security Ethics	3.21 - 3.58	0.28 - 0.31
Multimedia Presentations	2.98 - 3.23	0.31 - 0.34
Adaptability to New Technologies	2.89 - 3.14	0.32 - 0.35

Note: All VIF values < 10 and tolerance values > 0.20, indicating no multicollinearity concerns

4.4.5. Model assumptions and diagnostics

As presented in Table 10, all regression models met the assumptions for multiple linear regression. Variance Inflation Factor (VIF) values ranged from 2.74 to 4.09, well below the threshold of 10 recommended by Hair et al. [28] and O'brien [29] for detecting problematic multicollinearity among predictors. Tolerance values ranged from 0.24 to 0.36, all above the recommended minimum of 0.20, further confirming the independence of predictor variables.

4.4.6. Practical implications

The consistent emergence of Digital Literacy, Information Security Ethics, and Adaptability to New Technologies as significant predictors across research perception dimensions suggests that these three competencies represent core technological capabilities for research engagement. The substantial explained variance in most models (54.6% to 71.2%) indicates that technology skills development could serve as an effective intervention strategy for enhancing research attitudes and intentions among postgraduate students.

The particularly strong predictive relationships for Future Research Aspirations and research confidence dimensions suggest that technology skills development may be especially valuable for fostering long-term research engagement and self-efficacy among M.Ed. students.

4.5. Objective 5: Differences in technology skills and research perception based on demographic variables

This section presents the comparative analysis to address the fifth objective: analyzing differences in technology skills and research perception based on selected demographic variables (gender, type of college, and type of program). Independent samples *t*-tests were conducted to examine group differences across these demographic categories, with effect sizes calculated using Cohen's d to determine the practical significance of observed differences.

4.5.1. Gender-based differences

As presented in Table 11, the analysis revealed no statistically significant differences between male and female students across any of the research perception or technology skills domains (all $p > 0.05$). The effect sizes were universally small (Cohen's d ranging from -0.17 to 0.22), indicating negligible practical differences between genders. This finding suggests that gender does

Table 11
Gender differences in research perception and technology skills

Variable	Gender	N	Mean	*SD*	*t*-value	*df*	*p*-value	Cohen's *d*
Research Perception Domains								
Interest and Motivation	Male	18	4.20	0.79	-0.25	115	0.804	-0.06
	Female	99	4.26	0.91				
Confidence in Research Skills	Male	18	4.04	0.68	-0.12	115	0.905	-0.03
	Female	99	4.06	0.84				
Perceived Relevance of Research	Male	18	4.09	0.66	0.33	115	0.740	0.09
	Female	99	4.02	0.95				
Challenges and Frustrations	Male	18	3.52	0.65	0.00	115	1.000	0.00
	Female	99	3.52	1.01				
Collaboration and Networking	Male	18	4.10	0.67	0.06	115	0.950	0.02
	Female	99	4.09	0.91				
Research Ethics and Integrity	Male	18	4.02	0.71	-0.18	115	0.856	-0.05
	Female	99	4.06	0.93				
Future Research Aspiration	Male	18	3.87	0.83	-0.65	115	0.516	-0.17
	Female	99	4.03	0.95				
Impact and Dissemination	Male	18	3.99	0.83	0.08	115	0.937	0.02
	Female	99	3.97	0.97				
Technology Skills Domains								
Digital Literacy	Male	18	3.90	0.71	0.00	115	0.997	0.00
	Female	99	3.90	1.02				
Data Analysis Skills	Male	18	4.07	0.71	0.84	115	0.402	0.22
	Female	99	3.86	0.98				
Collaborative Technologies	Male	18	4.09	0.67	0.41	115	0.685	0.10
	Female	99	3.99	0.97				
Information Security Ethics	Male	18	3.93	0.84	-0.67	115	0.502	-0.17
	Female	99	4.09	0.91				
Multimedia Presentations	Male	18	4.13	0.63	0.36	115	0.718	0.09
	Female	99	4.05	0.91				
Adaptability to New Technologies	Male	18	4.07	0.70	0.11	115	0.912	0.03
	Female	99	4.04	0.88				

not substantially influence students' perceptions of research or their technological competencies in this sample.

The largest, albeit non-significant, difference was observed in Data Analysis Skills, where male students showed slightly higher mean scores ($M = 4.07$) compared to female students ($M = 3.86$, $d = 0.22$). However, this difference remains within the small effect size range and lacks statistical significance ($p = 0.402$).

4.5.2. Type of institution differences

Table 12 shows no statistically significant differences between private and government institution students across any measured domains (all $p > 0.05$). Effect sizes ranged from 0.01 to 0.35, with most falling in the small range. The largest effect was observed for Multimedia Presentations, where private institution students scored higher ($M = 4.25$) than government institution students ($M = 3.95$, $d = 0.35$), approaching but not reaching statistical significance ($p = 0.070$).

Interestingly, government institution students showed slightly higher scores in some research perception domains (Interest and Motivation, Challenges and Frustrations), while private institution students demonstrated marginally higher scores in most technology skills domains. However, these differences were not statistically

Table 12
Institutional type differences in research perception and technology skills

Variable	Institution Type	N	Mean	*SD*	*t*-value	*df*	*p*-value	Cohen's *d*
Research Perception Domains								
Interest and Motivation	Private	45	4.19	0.90	-0.57	115	0.571	-0.11
	Government	72	4.29	0.90				
Confidence in Research Skills	Private	45	4.19	0.69	1.37	115	0.173	0.26
	Government	72	3.98	0.88				
Perceived Relevance of Research	Private	45	4.03	0.84	0.02	115	0.981	0.01
	Government	72	4.03	0.95				
Challenges and Frustrations	Private	45	3.35	0.87	-1.52	115	0.130	-0.29
	Government	72	3.63	1.01				
Collaboration and Networking	Private	45	4.23	0.67	1.40	115	0.163	0.27
	Government	72	4.00	0.98				
Research Ethics and Integrity	Private	45	4.13	0.81	0.75	115	0.455	0.14
	Government	72	4.00	0.95				
Future Research Aspiration	Private	45	4.04	0.88	0.35	115	0.731	0.07
	Government	72	3.98	0.97				
Impact and Dissemination	Private	45	4.01	0.87	0.36	115	0.717	0.07
	Government	72	3.95	1.00				
Technology Skills Domains								
Digital Literacy	Private	45	4.04	0.92	1.20	115	0.234	0.23
	Government	72	3.81	1.01				
Data Analysis Skills	Private	45	4.04	0.91	1.37	115	0.174	0.26
	Government	72	3.80	0.96				
Collaborative Technologies	Private	45	4.08	0.93	0.67	115	0.502	0.13
	Government	72	3.96	0.93				
Information Security Ethics	Private	45	4.11	0.83	0.40	115	0.693	0.08
	Government	72	4.04	0.94				
Multimedia Presentations	Private	45	4.25	0.69	1.83	115	0.070	0.35
	Government	72	3.95	0.95				
Adaptability to New Technologies	Private	45	4.05	0.78	0.03	115	0.978	0.01
	Government	72	4.04	0.90				

meaningful, suggesting that institutional type does not significantly impact students' research perceptions or technology skills in this sample.

4.5.3. Program type differences

As shown in Table 13, the comparison between M.Ed. and MA students revealed no statistically significant differences across any domains (all $p > 0.05$). Effect sizes were consistently small, ranging from -0.25 to 0.19, indicating minimal practical differences between program types.

Contrary to expectations, M.Ed. students did not demonstrate significantly higher levels of research perception or technology skills compared to MA students. The largest difference was observed in Perceived Relevance of Research, where MA students scored slightly higher (M = 4.07) than M.Ed. students (M = 3.84, $d = -0.25$), though this difference was not statistically significant ($p = 0.287$).

4.5.4. Overall pattern and implications

The comprehensive analysis across all three demographic variables reveals a consistent pattern of non-significant differences, suggesting several important implications. This finding may indicate that the postgraduate student population in this study represents a relatively homogeneous group in terms of research perception and

Table 13
Program type differences in research perception and technology skills

Variable	Program	N	Mean	*SD*	*t*-value	*df*	*p*-value	Cohen's *d*
Research Perception Domains								
Interest and Motivation	M.Ed	22	4.39	0.57	0.78	115	0.437	0.19
	MA	95	4.22	0.95				
Confidence in Research Skills	M.Ed	22	3.97	0.70	-0.56	115	0.574	-0.13
	MA	95	4.08	0.84				
Perceived Relevance of Research	M.Ed	22	3.84	0.79	-1.07	115	0.287	-0.25
	MA	95	4.07	0.93				
Challenges and Frustrations	M.Ed	22	3.47	0.70	-0.26	115	0.793	-0.06
	MA	95	3.53	1.01				
Collaboration and Networking	M.Ed	22	4.09	0.63	0.01	115	0.995	0.00
	MA	95	4.09	0.93				
Research Ethics and Integrity	M.Ed	22	4.00	0.86	-0.31	115	0.756	-0.07
	MA	95	4.07	0.91				
Future Research Aspiration	M.Ed	22	3.95	0.81	-0.31	115	0.757	-0.07
	MA	95	4.02	0.97				
Impact and Dissemination	M.Ed	22	3.89	0.89	-0.48	115	0.632	-0.11
	MA	95	3.99	0.97				
Technology Skills Domains								
Digital Literacy	M.Ed	22	3.80	0.78	-0.53	115	0.599	-0.13
	MA	95	3.92	1.02				
Data Analysis Skills	M.Ed	22	3.75	0.76	-0.82	115	0.415	-0.19
	MA	95	3.93	0.98				
Collaborative Technologies	M.Ed	22	4.04	0.71	0.17	115	0.869	0.04
	MA	95	4.00	0.98				
Information Security Ethics	M.Ed	22	3.92	0.81	-0.85	115	0.398	-0.20
	MA	95	4.10	0.92				
Multimedia Presentations	M.Ed	22	4.02	0.66	-0.28	115	0.781	-0.07
	MA	95	4.08	0.91				
Adaptability to New Technologies	M.Ed	22	4.09	0.62	0.27	115	0.786	0.06
	MA	95	4.04	0.90				

Note: All *p*-values > 0.05 indicate no statistically significant differences

technology skills, regardless of demographic characteristics, possibly reflecting relatively equitable access to technology and research training opportunities within the Indian higher education system. The consistently small effect sizes and non-significant results should be interpreted considering the sample characteristics, particularly the notably uneven gender distribution (18 males vs. 99 females) and the relatively small M.Ed. sample (n = 22) compared to the MA sample (n = 95), which may have limited the power to detect meaningful differences. These findings suggest that educational interventions and support programs designed to enhance research perception and technology skills may not need to be differentially targeted based on gender, institutional type, or program category, supporting more inclusive and universally designed educational approaches that address the needs of all postgraduate students rather than assuming differential capabilities based on demographic characteristics.

To contextualize these null findings, we observe that the mean scores on both research perception and technology skill domains were generally high with relatively limited variation, a pattern consistent with potential ceiling effects that can diminish detectable group differences. Additionally, the significantly uneven gender distribution (18 males versus 99 females) limits statistical power for identifying small effects in gender comparisons. Together with the homogeneity of postgraduate curricular exposure, these factors offer plausible explanations for the consistently small effect sizes seen across Tables 11, 12, and 13.

5. Discussion

This study investigated the relationship between postgraduate students' technology skills and their perceptions toward research. The findings indicate that both constructs are positively aligned, with strong self-reported technological competencies significantly associated with students' confidence, motivation, and aspirations related to research.

These findings expand current international scholarship on digital competence and research engagement. For example, Han and Sa [7] observed persistent gender differences in East Asian higher education, while Abdullayeva [17] emphasized the role of institutional structures in shaping students' research attitudes. Conversely, the present study found no considerable demographic differences among Indian postgraduates. This divergence indicates that recent policy-driven digital expansion and the relative homogeneity of postgraduate curricula in India may have decreased disparities that are apparent in other contexts.

The Technology Skills Assessment Tool (TSAT) and Research Perception Scale (RPS) demonstrated high internal consistency, affirming the reliability of both instruments. Descriptive data showed that students rated themselves positively in domains such as *Interest and Motivation, Confidence in Research Skills*, and *Information Ethics and Security*, suggesting a strong orientation toward technology-supported research engagement.

Pearson correlations confirmed statistically significant relationships across all domains. Notably, *Digital Literacy* and *Collaborative Technologies* showed strong associations with *Future Aspirations* and *Collaboration and Networking*, respectively. These results suggest that students who possess advanced digital skills are more likely to envision sustained research participation and show readiness to work collaboratively.

Importantly, this trend was observed among students from both teacher education and social science disciplines, indicating that the connection between digital competence and research perception is not limited to professional education settings. By including participants from M.Ed. and MA programs, the study offers a comprehensive view that extends the scope of previous research, which often concentrated mainly on pre-service teachers. This contribution is notable because it expands the international evidence base with data from India, where digital and research reforms are still taking shape. The absence of demographic differences, in particular, challenges findings from many Western and East Asian studies, positioning this study as a counterpoint that informs both national and comparative scholarship.

The findings of this study make three clear contributions. First, they present one of the earliest empirical analyzes of the link between technology skills and research perception among postgraduate students in India, providing contextualized evidence to a literature mostly focused on Western and East Asian systems. Second, the lack of significant demographic differences across gender, program type, or institutional type contrasts with many international studies that report ongoing digital divides and variations in research self-efficacy [2, 7]. This difference might reflect the increasing policy emphasis on equitable access to digital and research opportunities under NEP 2020. However, other explanations, such as sample composition and ceiling effects, should also be considered. Third, by using two psychometrically validated instruments together, the study links technology skills and research perception—two constructs often studied separately—thus providing a comprehensive framework for enhancing postgraduate curricula.

5.1. Link to past research and theoretical models

These findings align well with the Technology Acceptance Model (TAM), which posits that perceived usefulness and ease of use of digital tools affect users' attitudes and behavioral intentions [7]. Students who are technologically competent may perceive research as less intimidating and more achievable, hence exhibiting greater interest and self-efficacy.

The study also supports the systematic review by Ifenthaler and Yau [6], who found that learning analytics and digital capabilities are strongly associated with academic success and engagement in higher education. In the current context, this connection is evident in how digital skills such as data analysis and ethical technology use significantly predict research confidence and engagement.

Further, the results echo Seraji et al. [10], who established that technological research skills are significantly linked to students' self-efficacy in research. In this study, such self-efficacy was reflected in high RPS scores for *Confidence, Future Aspirations*, and *Ethics and Integrity*.

5.2. Implications for postgraduate research and capacity-building

The findings have significant implications for postgraduate education, including both teacher education and non-education disciplines. In light of India's NEP 2020 emphasis on research and digital integration, institutions must embed targeted digital skill development, particularly in areas such as the ethical use of information, collaborative platforms, and data handling, into their research methodology courses.

For faculty members, academic developers, and curriculum designers across disciplines, this presents an opportunity to enhance research capacity by integrating research-based projects with digital tools, such as statistical software, content creation platforms, and collaborative learning environments. This would not only strengthen students' research perceptions but also prepare them for evidence-informed academic or professional practice.

Moreover, these findings offer validation for ongoing investments in technology-enabled learning and reinforce the need for capacity-building workshops that link digital fluency with academic inquiry.

Beyond confirming established links between technology skills and perceptions of research, this study's originality lies in its integrated analysis using psychometrically validated tools across multiple domains within the Indian context. By connecting digital literacy, ethics, and adaptability to research confidence, motivation, and aspirations, it offers a comprehensive view that is rarely explored in previous research. The absence of demographic divides observed here therefore provides not only a contextual insight but also a valuable comparative contribution to the global discussion on digital equity and research participation in higher education.

In comparative terms, this study shows that insights from India are not only local but also help challenge assumptions in global scholarship. The integrated framework used here, connecting digital competence and research perceptions through validated tools, can be adapted and tested in various higher education systems. Thus, the study enhances international discussions on digital equity and research capacity by providing evidence from a non-Western context where reforms are quickly transforming higher education.

An important social implication of these findings is the suggestion that access to digital tools and research opportunities may be becoming more equitable among postgraduate students in India. The lack of strong demographic divides in this study aligns with NEP 2020's emphasis on inclusivity, indicating that policy-driven digital expansion is helping to create equal opportunities across gender and institutional types. However, equity cannot be viewed as universal. Socio-economic disparities, differences in institutional digital infrastructure, and regional access variations remain ongoing challenges. Addressing these gaps is essential to ensure that the advantages of digital integration in higher education reach all learners, especially those from marginalized or resource-constrained backgrounds.

5.3. Unanticipated findings and alternative explanations

Contrary to expectations and prior literature suggesting disparities in digital access [13], this study found no significant differences in either technology skills or research perception based on gender, institution type, or program type. This may reflect an increasing democratization of digital access and research exposure across postgraduate programs, facilitated by institutional platforms, mobile technology, and blended learning environments following the COVID-19 pandemic.

The absence of demographic differences may reflect the democratizing effect of widespread mobile technology adoption and standardized digital infrastructure in Indian higher education post-COVID-19. This convergence suggests that traditional barriers related to gender, institutional resources, or program type may be diminishing, indicating a more equitable digital learning environment than previously documented in pre-pandemic studies.

It is also possible that the sample's exposure to similar foundational courses in research and technology minimized group-level disparities. This convergence, while encouraging, warrants further exploration using qualitative or longitudinal methods to elucidate the lived experiences underlying perceived competence and research engagement.

Beyond explanations of equitable access, several methodological and contextual factors may explain the absence of demographic differences. First, potential ceiling effects are indicated by the relatively high means and modest standard deviations across domains, which compress variance and diminish sensitivity to group differences. Secondly, sample homogeneity—resulting from largely similar postgraduate course structures and shared ICT/research experiences—may have led to converged competencies across gender, program, and institution. Thirdly, reliance on self-report measures, although psychometrically robust, may limit the detection of subtle group-level differences. Finally, the small male subsample ($n = 18$) reduces the precision of gender comparisons. These factors, together with international evidence highlighting gender or institutional disparities in digital competence and research self-efficacy, frame our findings as a valuable counterpoint from the Indian context and underscore the need for future research using multi-group measurement invariance testing and objective or behavioral indicators.

Another potential source of variation could be students' positions within postgraduate programs. However, in this study, all participants were enrolled in their first year of a Master's degree, which meant that differences between the early and later stages of study could not be examined. Future research should consider the year of study as an analytical factor to determine whether technology skills develop gradually and if this development leads to more positive research perceptions.

6. Conclusion and Implications

This study improves understanding of how digital competence and perceptions of research connect in postgraduate education. Using validated tools, the results show that students with stronger technology skills, especially in digital literacy, ethical practice, and adaptability, display greater confidence, motivation, and a future-oriented approach to research. The high correlation and predictive validity confirm that these skills are not just helpful but vital in shaping the academic research profiles of postgraduate students across different disciplines.

6.1. Practical recommendations

Postgraduate institutions, including those offering M.Ed. and M.A. programs, must move beyond basic ICT training and incorporate discipline-specific digital fluency into research preparation. Application-based modules, such as the use of digital tools for data analysis, virtual collaboration, and ethical sourcing, should be emphasized to bridge the gap between digital competence and research capability. Curriculum designers are encouraged to integrate research methodology with specific digital tools (statistical software, collaborative platforms, citation management) rather than teaching them separately. Skill-based research projects that require students to design, execute, and present findings using digital platforms can further enhance confidence and engagement in applied research.

6.2. Directions for future research

Future investigations could:

1) Monitor long-term shifts in research perception as students advance through digitally integrated coursework.
2) Analyze the impact of emerging technologies (e.g., GAI, collaborative apps) on postgraduate research skills.
3) Conduct comparative studies across disciplines or regions to examine the wider applicability of findings.

It should also be acknowledged that reliance on self-reported competence may not capture actual skills or behaviors. Future research should therefore include objective or behavioral assessments to triangulate findings.

6.3. Study limitations

This study has several limitations that should be taken into account. First, the cross-sectional design restricts the interpretation of the findings to correlation rather than causation. While the results indicate meaningful links between technology skills and research perceptions, it is not possible to determine whether enhanced digital competence improves research perceptions or if students with stronger research orientations are more likely to develop their technology skills. Future research employing longitudinal studies or experimental interventions would be necessary to clarify the direction of these relationships and establish causality.

Secondly, the use of self-report measures may introduce social desirability bias, particularly in claims about technological competence. Although the scales used demonstrated high reliability and validity, relying on self-report can result in exaggerated or inaccurate claims that might not reflect actual practice. Self-perceptions often differ from observable performance, particularly in areas such as digital literacy or research problem-solving. Therefore, future studies should incorporate objective assessments, such as task-based digital evaluations, supervisor ratings, or behavioral indicators from learning platforms, to verify and expand the findings. Using a combination of self-report with interviews or portfolio analysis through mixed-methods approaches would also provide a more comprehensive understanding.

Thirdly, the sample's gender distribution (85% female) and program imbalance (81% M.A.) may limit the generalisability of the results. These imbalances, along with the relatively small number of male participants, may also have constrained the ability to identify potential demographic differences.

Finally, relying solely on self-perceived competencies instead of observed or tested abilities introduces a further limitation. Incorporating multiple sources of evidence, such as supervisor evaluations, task-based performance measures, or longitudinal case studies, would enhance the reliability of future findings.

6.4. Broader implications

By placing Indian evidence within broader international discussions, the study questions traditional assumptions about ongoing digital divides and emphasizes the potential for policy-driven reforms to bridge these gaps. The framework created here can also serve as a basis for comparative research across diverse higher education systems, allowing examination of how technology skills and research perceptions interact in different cultural and institutional settings.

Overall, the study makes a novel contribution by exploring the connection between technology skills and research perception within the reform-focused context of Indian higher education. Its findings emphasize the importance of integrating digital skill development with research training in postgraduate programs, while also providing comparative insights for the international literature.

Ethical Statement

Due permission for conducting the study was obtained from the Research and Development Cell of the College. As the study involved non-invasive, anonymous survey responses from higher education students, no further formal clearance was required. All procedures were conducted in accordance with institutional guidelines for ethical research. Informed consent was obtained from all participants prior to data collection. Participants were clearly informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any stage.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Adit Gupta: Conceptualization, Methodology, Software, Validation, Formal analysis, Writing – original draft, Writing – review & editing. **Bindu Dua:** Conceptualization, Methodology, Investigation, Resources, Data curation, Writing – review & editing, Supervision, Project administration.

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