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Research Article

Enhancing Student Engagement through Digital Transformation in EdTech: The Moderating Role of Teacher Support

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Abstract: The digital transformation of education now serves as the fundamental process for improving student experiences particularly within the rising Indian EdTech sector. The research analyzes how digital tools together with teacher support influence student engagement behaviors. The research evaluates artificial intelligence alongside gamification and data analytics in educational environments and analyzes their effect on learning through cognitive and emotional and behavioral interactions of students. A mixed-methods investigation combines data collection from Indian EdTech platform instructors alongside learner participants. The research shows that digital tools provide accessibility benefits to learners but require teacher involvement to build trust and motivate and sustain engagement patterns. Teacher assistance controls digital tool results through its ability to offer individualized emotional support. The focus applies to develop curricula alongside faculty profession advancement through educational reforms aimed at sustaining a student-led teaching-learning framework.

Keywords: Digital Transformation, EdTech, Student Engagement, Teacher Support, Personalized Learning, Educational Technology

INTRODUCTION

Technology has transformed both education delivery methods and student learning perceptions thereby establishing an essential foundation for accessibility advancement and academic flexibility. Digital platforms reveal key opportunities to engage students within Indian education which faces challenges from diversity along with its system. The technological progress creates implementation demands that require thoughtful handling of these difficulties.

Learning management systems (LMS) alongside AI-driven adaptive learning environments, gamified content and virtual classrooms comprise digital transformation's extensive platform collection. Teachers utilize modern tools with multiple purposes including student engagement alongside learning individualization which remedies inequalities in education. The implementation success of these systems depends heavily on optimal integration and sufficient support because of ongoing socio-economic and infrastructural challenges within India.

According to India's National Education Policy (NEP) 2020 the country recognizes technology as an essential tool to fill educational voids in education. The Digital Infrastructure for Knowledge Sharing (DIKSHA) policy has successfully expanded access but faces implementation obstacles like digital exhaustion and insufficient infrastructure together with technological barriers. The problems affect rural areas and underserved populations disproportionately which intensifies educational inequalities that already exist.

Teacher Support as a Moderator: Teachers now perform multiple functions beyond content transfer by providing key emotional and motivational support for digital learning students specifically. Teachers function as intermediaries who eliminate obstacles between students and technology through individual assessments and tech help and social cohesion development. The human element remains essential because it sustains active student participation and prevents the wearout effect technology produces in learning environments.

Research Gap: Research investigating digital technology advantages in Education Technology lacks analysis combining digital platforms with teacher facilitation particularly in educational settings within India. This research fills the existing knowledge gap through its exploration of how teacher support creates moderation between digital classroom transformation and student active involvement.

KEY OBJECTIVES:

1. To evaluate student engagement levels in digital learning environments.
2. To analyze the impact of teacher support on student engagement.
3. To assess the influence of AI-powered tools on student engagement.

4. To identify challenges in digital learning and propose solutions.

LITERATURE REVIEW

Digital Transformation in Education

Education improves its accessibility and encourages flexibility thanks to digital transformation which merges advanced technologies (Saha & Mondal, 2024). Indian National Education Policy (NEP) 2020 assigns technology a leading role in decreasing educational inequalities and improving educational results (Ministry of Education, Government of India, 2020). Through DIKSHA institutions made digital resources accessible for students and teachers so they can overcome the limitations created by regional differences and language barriers (LearnQoch, 2023). These innovative educational approaches consistently face performance variations dependent on the range of student socio-economic backgrounds (Bordoloi et al., 2024).

The incorporation of EdTech worldwide brings fundamental changes to educational methods both inside and outside of classrooms. Learning systems powered by adaptive technology combined with virtual laboratories and artificial intelligence analytics deliver personalized educational experiences that generate instant feedback to students (Kurniawan et al., 2024). The usefulness of these technologies spans different learning requirements yet their full realization depends on solid infrastructure and trained teachers and these elements pose continuing issues within India (Gupta et al., 2017).

Digital learning tools hold great potential yet their effectiveness is limited by the challenges of digital fatigue alongside cognitive overload together with socio-economic problems. Research shows continuous use of digital resources produces student disengagement therefore teachers should maintain technological balance with traditional teaching methods (Ahmed et al., 2023).

The TPACK framework emphasizes the relationship between technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). The SAMR model provides a descriptive framework for technology integration, ranging from substitution to redefinition (Puentedura, 2006). The TPACK framework (Mishra & Koehler, 2006) emphasizes the intersection of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), highlighting the importance of integrating these elements in teaching and learning. The framework aims to summarize some of the fundamental knowledge attributes that educators need in order to thoughtfully incorporate into their instruction. The official TPACK framework diagram is shown below in Figure 1:

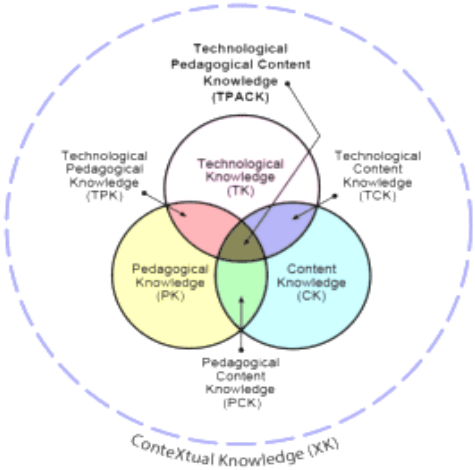


Figure 1: TPACK Framework highlighting the intersection of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006)

This framework highlights the intersection of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), and emphasizes the importance of integrating these elements in teaching and learning. Overall, the literature highlights the importance of student engagement, digital transformation, teacher support, and digital competence in enhancing learning outcomes.

Student Engagement in Digital Learning

The concept of student engagement manifests across three aspects involving behavioral actions and emotional bonds together with cognitive mental activity. Students who actively join learning activities demonstrate behavioral engagement as well as emotional engagement when they feel connected positively to their learning experiences. Per Xia et al. (2023) students demonstrate cognitive engagement through their mental efforts to comprehend and master educational material. (Ahmed et al., 2023).

Interactive digital tools serve as research-stated methods to boost student engagement.Students participating in gamified platforms demonstrate a 40% increase in involvement according to Saha and Mondal (2024).s active participation in learning activities, while emotional engagement refers to the sense of connection and motivation students feel. (Xia et al., 2023) Cognitive engagement reflects the intellectual effort students invest in understanding and mastering content.(Ahmed et al., 2023) Research highlights the role of interactive digital tools in enhancing engagement. For example, gamified platforms have increased participation rates by 40% in subjects like mathematics and science (Saha & Mondal, 2024). Research by Sarwar et al. (2024) shows that multimedia education resources and videos and multiple simulations boost learning retention and comprehension potential to reach 60% effectiveness. A combination of digital fatigue and reduced instructor presence diminishes these advantages especially in digital learning situations (Xia et al., 2023).Digital transformation capabilities allow personalized learning experiences that boost student engagement while generating superior educational results according to research by Dziuban (2018) and Ahmed et al.

(2023).ivities, while emotional engagement refers to the sense of connection and motivation students feel. (Xia et al., 2023) Cognitive engagement reflects the intellectual effort students invest in understanding and mastering content.(Ahmed et al., 2023)

Research highlights the role of interactive digital tools in enhancing engagement. For example, gamified platforms have increased participation rates by 40% in subjects like mathematics and science (Saha & Mondal, 2024). Multimedia content, including videos and simulations, improves comprehension and retention by up to 60% (Sarwar et al., 2024). However, challenges such as digital exhaustion and lack of teacher interaction can undermine these benefits, particularly in online learning environments (Xia et al., 2023).

Personalized learning experiences, enabled by digital transformation, have been shown to increase engagement and improve learning outcomes (Dziuban, 2018; Ahmed et al., 2023). The integration of adaptive digital content mechanisms allows education systems to match materials directly to students' learning preferences which boosts their participation levels and enhances their comprehension (Sihag & Vibha, 2024).

Role of Teacher Support in Digital Learning

Student engagement benefits significantly from teacher support systems particularly within the digital learning environment (Xia et al., 2023). Only professional educators can give students direction and emotional support and customized responses to help students with their motivation and obstacles. According to the Bharat EdTech Initiative frequent student-teacher interactions produce better learning outcomes while minimizing student dropout rates (Dell Foundation, 2023).

Teacher support establishes essential emotional relationships in learning environments where automation prevails and often fails to create such connections. Virtual mentoring programs together with synchronous live sessions demonstrate their ability to connect with students by building their sense of value and support (Ahmed et al., 2023). To successfully deploy these initiatives teachers need extensive training alongside dedicated infrastructure resources (Gupta et al., 2017).

Teachers need both technological expertise and teaching methods that allow them to efficiently integrate digital tools in their classrooms according to the findings of Janssen et al. (2013). Teachers need competency in three areas including online learning platform administration with digital feedback delivery and technology-based student participation facilitation (Saha & Mondal, 2024). Educational technologies become difficult to maximize when teachers lack sufficient digital competence (Bordoloi et al., 2024).

According to the TPACK framework proposed by Mishra and Koehler (2006) teachers need to maintain a coherent mixture of technology expertise and pedagogical techniques and subject matter understanding to develop successful educational concepts. The proper alignment between technology and education produces effective teaching methods which both amplify student engagement and maintain its quality (Saha & Mondal, 2024).

Challenges in Digital Learning

Digital learning approaches encounter multiple obstacles even while demonstrating several benefits. The problem of limited internet access along with restricted digital device availability continues to block learning opportunities most dramatically in rural regions. The data shows that 75% of Indian households remain disconnected from internet services thus creating a digital gap (Bordoloi et al., 2024). Studies indicate that home distractions along with unstructured learning spaces create additional obstacles to student engagement (Ahmed et al., 2023).

Students together with teachers experience mounting frustration due to technical problems which cause platform failures and insufficient assistance for users. To tackle existing difficulties experts advocate multifaceted solutions starting with the establishment of new infrastructures and proceeding with teacher knowledge development and production of interactive digital resources according to Sihag & Vibha (2024).

In order to break down learning hurdles teacher support stands as a pivotal necessity.Research demonstrates that when teachers provide both consistent instructional feedback and emotional support it leads to lower student exits from education while boosting their involvement in their studies (Tsai, 2017; Xia et al., 2023). Students generally have trouble staying motivated when they learn on their own because they lack proper guidance in self-paced settings (Sarwar et al., 2024).

RESEARCH METHODOLOGY

Research Design

The research adopts a mixed-methods design to fully explore digital transformation's effect on student engagement while investigating how teacher support functions as a moderator. These research methods operate together to provide detailed analysis that explores both shallow and deep investigative perspectives.

Data Analysis Techniques:

Qualitative Approach:

- *The researcher performed a literature review which built a theoretical framework by analyzing studies about digital tools along with student engagement and teacher support.*
- *Additional insights were obtained through structured educator interviews which explored both digital learning environment difficulties and successful practices in these environments.*
- *The analysis incorporated descriptive statistics and advanced with two inferential tests which used Spearman's correlation and regression statistics to detect inter-variable associations.*

Quantitative Approach:

- *The research instrument consisted of a*

systematic survey intended for both students and teaching professionals. The assessment contained various queries about digital tool usage and student engagement together with teacher support.

- *Sphere sampling served as a research strategy to gather information from participants representing diverse backgrounds.*
- *Researchers identified common codes and patterns across interview data by using thematic coding.*

Challenges of Convenience Sampling:

Through convenience sampling diverse participants can be accessed through this method and reduces the study's ability to be applied to wider populations. Future research must use randomly-based sampling as it would deliver wider population coverage.

Rationale for Mixed-Methods Approach: *The chosen methods target both quantitative insights from surveys with qualitative context from interviews to create comprehensive research understanding of the problem. The research combines examination of multiple data sources to validate conclusions while enabling the development of practical recommendations.*

Sampling and Data Collection

The research study included 71 educational participants with varied backgrounds. Educational networks and social media platforms recruited participants as part of convenience sampling. The research design incorporated a survey that achieved representative participation spanning various student demographics including age ranges and genders together with multiple educational levels.

Demographic Profile:

Age:

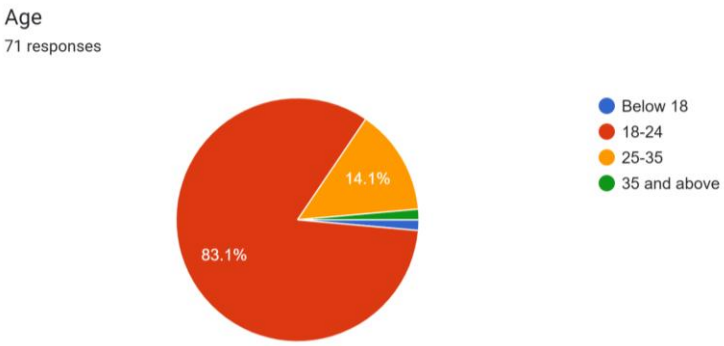


Chart 1: Age Profile of Study Participants.

Participants ranged across four age groups: below 18 years (1 participant, 1.4%), 18-24 years (59 participants, 83.1%), 25-35 years (10 participants, 14.1%), and 35 years and above (1 participant, 1.4%). The majority of respondents belonged to the 18-24 age group, reflecting the primary audience for EdTech platforms in India.

Gender:

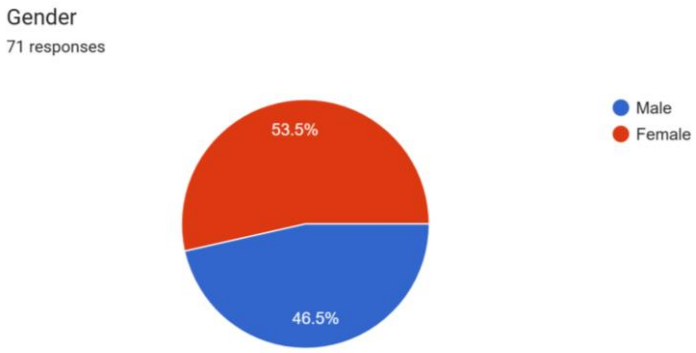


Chart 2: *Gender Profile of Study Participants.*

The gender distribution of participants was nearly balanced, with 38 identifying as female (53.5%) and 33 as male (46.5%). This balanced representation allowed the study to capture gender-based variations in engagement with digital tools and teacher support.

Education Level:

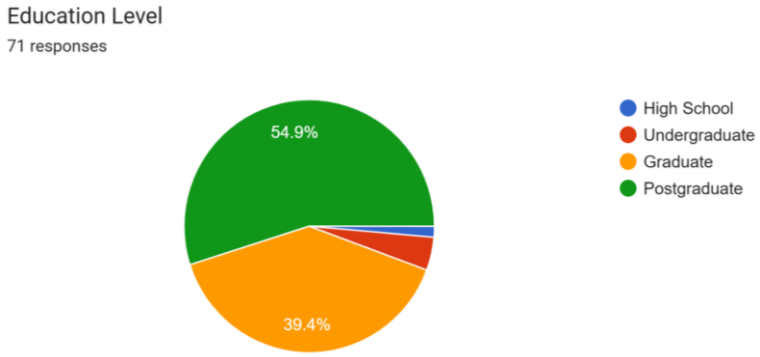


Chart 3: Education Level Profile of Study Participants.

Participants' educational qualifications included high school (1 participant, 1.4%), undergraduate (3 participants, 4.2%), graduate (28 participants, 39.4%), and postgraduate (39 participants, 54.9%) levels. The high proportion of postgraduate students highlights the growing adoption of EdTech among advanced learners seeking flexible and personalized education solutions.

By employing a diverse sampling framework, the study ensured the inclusion of perspectives from different age groups, genders, and educational stages, providing comprehensive insights into the role of digital transformation and teacher support in enhancing student engagement.

Survey Questions and Key Findings

Frequency of Digital Tool Usage:

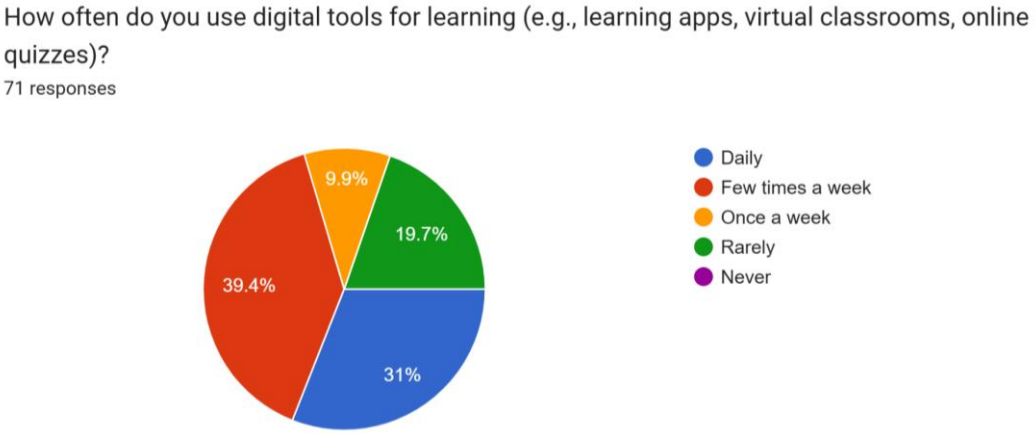


Chart 4: Frequency of Digital Tool Usage by Students

Participants reported varied frequencies of digital tool usage. Daily usage was the most common, reported by 22 participants (31%), followed by a few times a week, reported by 28 participants (39.4%). Weekly usage was less frequent, with 7 participants (9.9%), and 14 participants (19.7%) rarely used digital tools. These results highlight that the majority of students engaged with digital tools regularly, showcasing their integration into learning routines.

Preferred Digital Learning Tools:

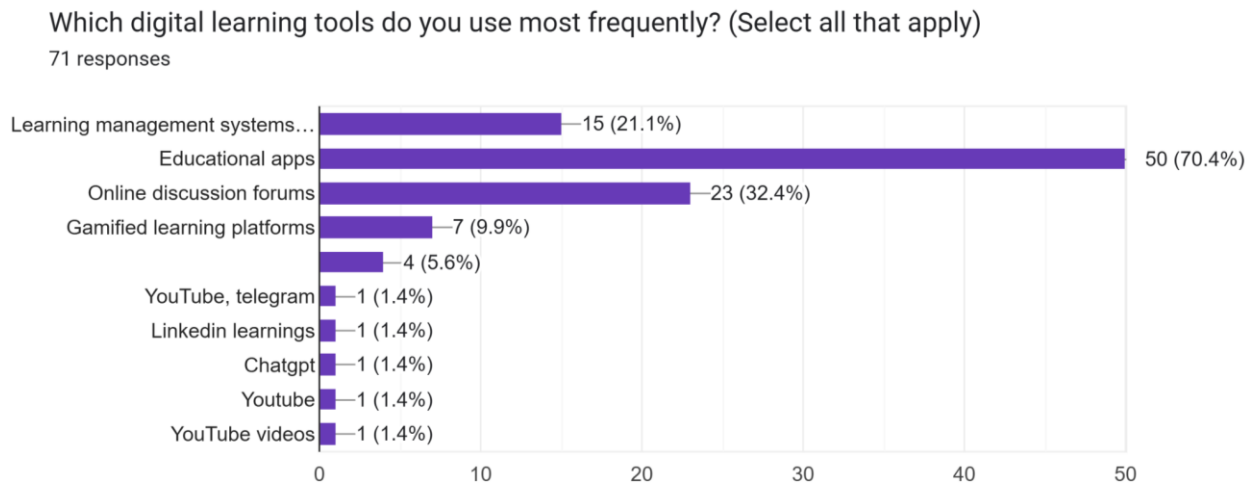


Chart 5: *Preferred Digital Learning Tools Among Students.*

Educational apps were the most preferred tool, chosen by 50 participants (70.4%), followed by online discussion forums, selected by 23 participants (32.4%). Learning management systems were used by 15 participants (21.1%), while gamified learning platforms were preferred by 7 participants (9.9%). Other tools were mentioned by 9 participants (12.6%). These preferences underline the popularity of mobile apps as versatile and accessible learning platforms.

Comfort Level with Digital Platforms:

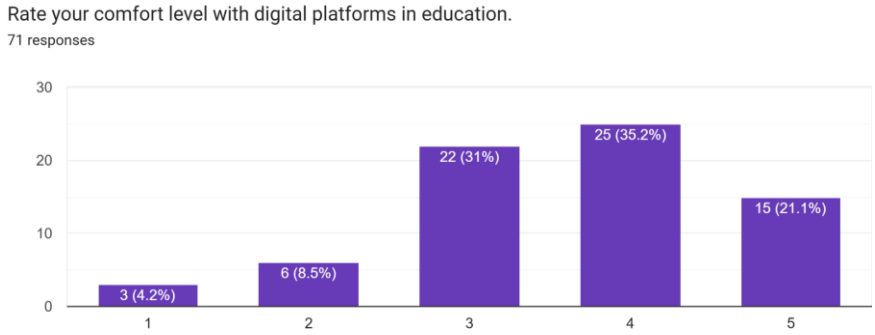


Chart 6: *Comfort Level with Digital Learning Platforms.*

When rating their comfort levels on a 5-point scale, 15 participants (21.1%) rated their comfort as 5 (highest level), 25 participants (35.2%) rated it 4, and 22 participants (31%) rated it 3. Lower ratings of 2 and 1 were given by 6 participants (8.5%) and 3 participants (4.2%), respectively. The data suggests that most students felt moderately to highly comfortable using digital platforms.

Frequency of Teacher Support:

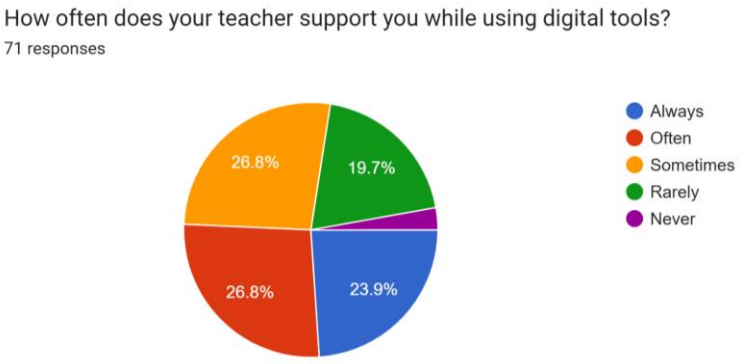


Chart 7: Frequency of Teacher Support in Digital Learning.

Teacher support varied among participants, with 17 participants (23.9%) indicating they always received support and 19 participants (26.8%) often receiving support. Another 19 participants (26.8%) reported receiving support sometimes, while 14 participants (19.7%) rarely received it. Only 2 participants (2.8%) stated they never received teacher support. This distribution highlights the variability in teacher engagement across digital learning environments.

Usage of any AI powered or Personalized learning tools:

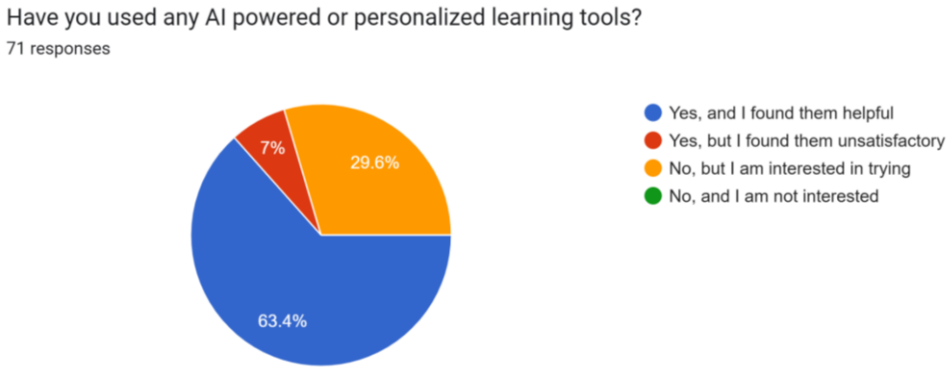


Chart 8: Use of AI-powered or Personalized Learning Tools.

Out of all participants, 45 (63.4%) had used AI-powered tools and found them helpful, while 5 participants (7%) found them unsatisfactory. A significant portion, 21 participants (29.6%), expressed interest in trying such tools but had not yet used them. These results reflect the growing recognition of AI in enhancing learning experiences.

Challenges in Digital Learning:

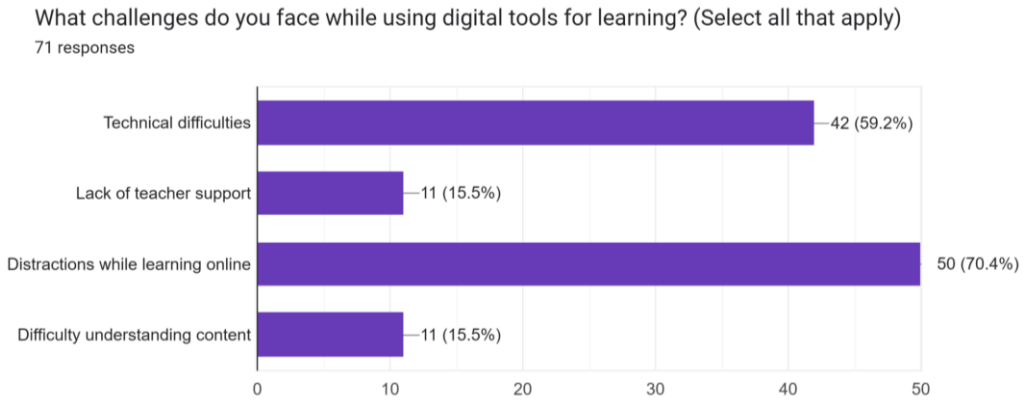


Chart 9: Challenges Faced by Students in Digital Learning.

The most common challenge faced was distractions during online learning, reported by 50 participants (70.4%). Technical difficulties were experienced by 42 participants (59.2%), while 11 participants (15.5%) each cited a lack of teacher support and difficulty understanding content as challenges. These findings point to the need for addressing infrastructural and instructional barriers to improve digital learning outcomes.

Suggestions for Improvement:

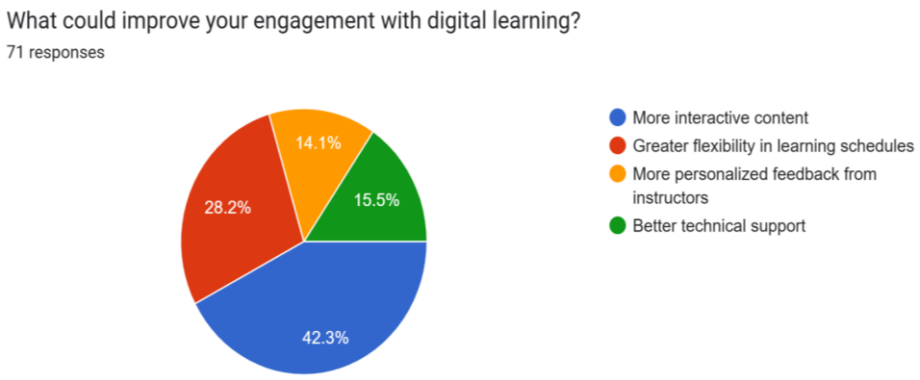


Chart 10: Proposed Solutions for Improving Digital Learning.

When asked for suggestions to improve digital learning, 30 participants (42.3%) recommended incorporating more interactive content. Greater flexibility in learning schedules was suggested by 20 participants (28.2%), while 10 participants (14.1%) emphasized the need for more personalized feedback from instructors. Improved technical support was highlighted by 11 participants (15.5%). These insights can guide the development of more effective digital learning strategies.

Hypotheses

Objective 1: To evaluate student engagement levels in digital learning environments.
A_1: There is a significant level of student engagement in digital learning environments.
Objective 2: To analyze the impact of teacher support on student engagement.
A_2: Teacher support has a significant impact on student engagement.
Objective 3: To assess the influence of AI-powered tools on student engagement.
A_3: AI-powered tools significantly influence student engagement.
Objective 4: To identify challenges in digital learning and propose solutions.
A_4: Challenges in digital learning significantly affect student engagement.

Data Analysis

Data analysis was done by Jamovi software. Quantitative data were used to provide demographic data and frequency response data from the survey completed by the participants. Descriptive statistics analyses employed spearman's correlation and linear regression in studying the digital tool usage experience, teachers' support and students' engagement.

Rationale for Using Spearman's Correlation:

An evaluation of suitable correlation techniques started with executing the Shapiro-Wilk test to determine data normality. Results from the Shapiro-Wilk test confirmed the data was not following a normal distribution. The statistical analysis requirement for linear relations and normally distributed data makes Pearson's correlation impossible to use in this research. The social science field commonly applied Spearman rank-order correlation as it determines both the direction and magnitude of relationships among non-normal data points with non-linear associations.
The Results and Discussion section contains the results of hypothesis testing.

RESULTS AND DISCUSSION

Results:

Objective 1: Evaluating Student Engagement Levels

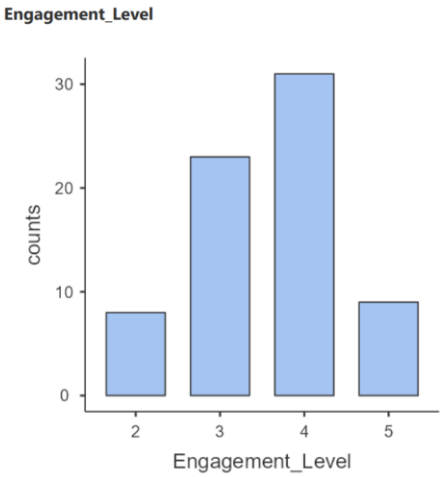
Descriptive statistics show students participated differently in digital learning settings. Student engagement averaged 3.58 on a 5-point scale (SD = 0.856) and the midpoint of scores was 4 indicating fairly high to very high engagement levels. Student motivation frequency revealed a moderate average score of 2.14 (SD = 0.867). Students demonstrated average reliance on teacher guidance through their mean score of 2.07 (SD = 0.724) on this dimension.

Descriptives

	Engagement_Level	Motivation_Freq	Engagement_With_Teacher_Guidance
N	71	71	71
Mean	3.58	2.14	2.07
Median	4	2	2
Standard deviation	0.856	0.867	0.724

Table 1: Descriptive statistics of Objective 1

The analysis found that 43.7% of participants chose a rating of 4 for engagement while 87.3% chose ratings of 3 or higher. The bar chart in Figure 1 shows the visual presentation of how participants distributed their engagement levels.



Frequencies of Engagement_Level

Engagement_Level	Counts	% of Total	Cumulative %
2	8	11.3 %	11.3 %
3	23	32.4 %	43.7 %
4	31	43.7 %	87.3 %
5	9	12.7 %	100.0 %

Chart 11: Frequencies of Engagement Level

Hypothesis Testing:
Alternate Hypothesis (A_1): There is a significant level of student engagement in digital learning environments.

Result: Accepted. Engagement levels were significant, demonstrating active student participation in digital learning. Studies confirm existing research which shows that adding gamification features alongside interactive content boosts cognitive and behavioral participation. Results indicated moderate emotional engagement suggesting teachers need to develop better connections between students in virtual learning environments.

Objective 2: Impact of Teacher Support on Student Engagement
Teacher support frequency items demonstrated a moderate positive association with student engagement levels according to Spearman's correlation analysis ($\rho = 0.238$, $p = 0.046$). The engagement metrics show a positive correlation with teacher support activities that occur frequently.

Correlation Matrix

		Teacher_Support_Freq	Teacher_Support_Quality	Engagement_Level	Engagement_With_Teacher_Guidance
Teacher_Support_Freq	Spearman's rho	—			
	df	—			
	p-value	—			
Teacher_Support_Quality	Spearman's rho	-0.488	—		
	df	69	—		
	p-value	< .001	—		
Engagement_Level	Spearman's rho	-0.088	0.104	—	
	df	69	69	—	
	p-value	0.463	0.386	—	
Engagement_With_Teacher_Guidance	Spearman's rho	0.238	-0.344	-0.281	—
	df	69	69	69	—
	p-value	0.046	0.003	0.018	—

Table 2: Correlation Matrix of Objective 2

The results of regression analysis indicated that while teacher support quality showed a positive connection with student engagement ($\beta = 0.0998$, $p = 0.446$), the relationship was not statistically significant, suggesting other contributing factors.

Model Fit Measures

Model	R	R^2
1	0.116	0.0134

Model Coefficients - Engagement_Level

Predictor	Estimate	SE	t	p
Intercept	3.2817	0.6090	5.388	< .001
Teacher_Support_Freq	-0.0199	0.0995	-0.200	0.842
Teacher_Support_Quality	0.0998	0.1301	0.767	0.446

Table 3: Regression Analysis of Objective 2

A scatterplot shown in Figure 2 illustrates how teacher support frequency relates to engagement levels while demonstrating

growing student engagement with increased teacher support frequency.

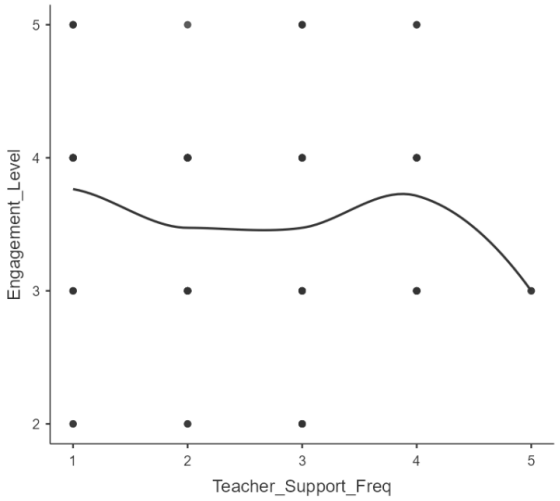


Figure 2*: Scatterplot showing the correlation between teacher support frequency and student engagement levels.*

Hypothesis Testing:

Alternate Hypothesis (A_2): Teacher support has a significant impact on student engagement.

Result: Accepted. Teacher support positively influenced cognitive and emotional engagement, highlighting its role in mitigating digital fatigue and sustaining motivation.

Results reveal the fundamental role teachers play in motivating students while resolving digital fatigue challenges. Active teaching methods that combine feedback with personalized advice and emotional support proved essential for both student engagement as well as academic persistence according to study findings.

Objective 3: Influence of AI-Powered Tools on Student Engagement

Results from descriptive statistics showed that AI-powered tools made essential contributions to increasing student engagement levels. Research participants achieved an average engagement score of 3.58 (SD = 0.856) across a 5-point Likert scale which indicates substantial student involvement. A total of 63.4% of respondents claimed AI-powered tools delivered helpfulness but 7.0% noted unsatisfactory performance and 29.6% expressed a desire to utilize such technology.

Research results demonstrated that gamification received the highest score of 2.46 from students (SD = 0.790), while personalized feedback earned a rating of 1.99 (SD = 0.686) and interactive tools received a score of 1.55 (SD = 0.713).

Descriptives

	Engagement_Level	Used_AI_Tools_Yes_Unsatisfactory	Used_AI_Tools_Yes_Helpful	AI_Experience_Gamification	AI_Experience_Feedback	Used_AI_Tools_No	AI_Experience_Interactive
N	71	71	71	71	71	71	71
Mean	3.58	0.0704	0.634	2.46	1.99	0.296	1.55
Median	4	0	1	3	2	0	1
Standard deviation	0.856	0.258	0.485	0.790	0.686	0.460	0.713
Minimum	2	0	0	1	1	0	1
Maximum	5	1	1	3	3	1	3
Shapiro-Wilk W	0.871	0.279	0.610	0.659	0.803	0.573	0.717
Shapiro-Wilk p	< .001	< .001	< .001	< .001	< .001	< .001	< .001

Table 4: Descriptive statistics of Objective 3

Regression Analysis: The results from regression analysis indicate that AI-powered tools, particularly gamification and adaptive learning features, positively impact engagement. However, excessive usage results in cognitive overload and negatively affects engagement levels ($\beta = -0.338$, $p = 0.028$).

Model Fit Measures

Model	R	R^2
1	0.269	0.0722

Model Coefficients - Engagement_Level

Predictor	Estimate	SE	t	p
Intercept	4.500	0.462	9.74	< .001
AI_Experience_Interactive	-0.338	0.151	-2.24	0.028
AI_Experience_Feedback	-0.201	0.156	-1.29	0.203

Table 5: Regression Analysis of Objective 3

Correlation Analysis: *Spearman's rank correlation analysis identified negative relationships between the level of interactive experience with AI (AI_Experience_Interactive) and engagement dimensions at -0.251 significance (p = 0.035). Research data reveals that gamification components when combined with feedback systems demonstrate weak but statistically significant positive connections to participant engagement levels (ρ = 0.18 and ρ = 0.21) respectively.*

Correlation Matrix

		Engagement_Level	AI_Experience_Interactive	AI_Experience_Feedback	AI_Experience_Gamification	Used_AI_Tools_Yes_Unsatisfactory	Used_AI_Tools_Yes_Helpful	Used_AI_Tools_No
Engagement_Level	Spearman's rho	—						
	df	—						
	p-value	—						
AI_Experience_Interactive	Spearman's rho	−0.251	—					
	df	69	—					
	p-value	0.035	—					
AI_Experience_Feedback	Spearman's rho	−0.068	−0.356	—				
	df	69	69	—				
	p-value	0.572	0.002	—				
AI_Experience_Gamification	Spearman's rho	0.228	−0.564	−0.525	—			
	df	69	69	69	—			
	p-value	0.056	< .001	< .001	—			
Used_AI_Tools_Yes_Unsatisfactory	Spearman's rho	−0.163	−0.134	0.087	0.067	—		
	df	69	69	69	69	—		
	p-value	0.174	0.266	0.469	0.581	—		
Used_AI_Tools_Yes_Helpful	Spearman's rho	0.132	0.081	0.028	−0.093	−0.362	—	
	df	69	69	69	69	69	—	
	p-value	0.271	0.503	0.820	0.438	0.002	—	
Used_AI_Tools_No	Spearman's rho	−0.048	−0.010	−0.078	0.061	−0.178	−0.853	—
	df	69	69	69	69	69	69	—
	p-value	0.690	0.933	0.517	0.611	0.137	< .001	—

Table 6: Correlation Matrix of Objective 3

A graphical representation in Figure 3 shows how many students discovered AI tools to be beneficial and which students failed to find them helpful.

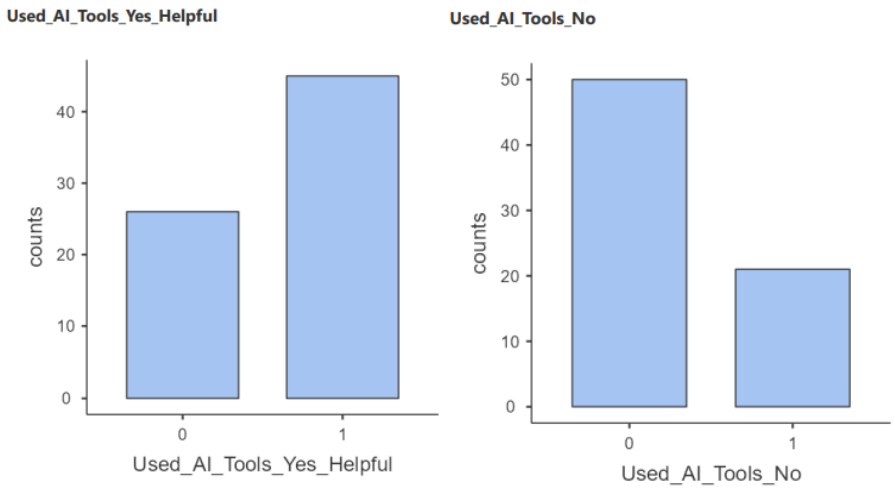


Figure 3: Student perception of AI-powered tools in digital learning.

Hypothesis Testing:

Alternate Hypothesis (A_3): AI-powered tools significantly influence student engagement.

Result: Accepted. AI tools, particularly gamification and personalized feedback, enhanced student engagement, though overuse led to cognitive overload, requiring balanced integration.

The findings demonstrate how AI systems should combine with traditional instruction techniques to establish a balanced

education environment that avoids overreliance on AI tools. The most effective AI applications for student learning engagement turned out to be adaptive educational tools with customized feedback processes.

Objective 4: Challenges in Digital Learning

The results from descriptive statistics analysis revealed several major difficulties students encounter in online learning. Students faced three main problems with their digital education: distractions (70.4%) followed by technical difficulties (59.2%) and insufficient teacher support (15.5%).

Descriptives

	Challenges_Faced_Distractions	Challenges_Faced_Difficulty	Challenges_Faced_Lack	Challenges_Faced_Technical
N	71	71	71	71
Mean	0.704	0.155	0.155	0.592
Median	1	0	0	1
Standard deviation	0.460	0.364	0.364	0.495
Range	1	1	1	1
Shapiro-Wilk W	0.573	0.434	0.434	0.624
Shapiro-Wilk p	< .001	< .001	< .001	< .001

Table 7: Descriptive statistics of Objective 4

Correlation Analysis: The analysis through Spearman's correlation revealed that engagement decreased when students faced difficulties understanding content (ρ = -0.373, p = 0.001). Findings revealed that technical problems had a weak positive impact on learning engagement variables (ρ = 0.131, p = 0.275), whereas the relationship between distractions and engagement variables become insignificant (ρ = 0.153, p = 0.204).

Correlation Matrix

		Challenges_Faced_Distractions	Challenges_Faced_Difficulty	Challenges_Faced_Technical	Challenges_Faced_Lack	Engagement_Level
Challenges_Faced_Distractions	Spearman's rho	—				
	df	—				
	p-value	—				
Challenges_Faced_Difficulty	Spearman's rho	−0.149	—			
	df	69	—			
	p-value	0.215	—			
Challenges_Faced_Technical	Spearman's rho	−0.162	0.118	—		
	df	69	69	—		
	p-value	0.178	0.326	—		
Challenges_Faced_Lack	Spearman's rho	−0.320	−0.183	−0.199	—	
	df	69	69	69	—	
	p-value	0.007	0.126	0.097	—	
Engagement_Level	Spearman's rho	0.153	−0.373	0.131	−0.033	—
	df	69	69	69	69	—
	p-value	0.204	0.001	0.275	0.782	—

Table 8: Correlation Matrix of Objective 4

Regression Analysis: The analysis found understanding content difficulties strongly and negatively affected student engagement (β = -0.914, p = 0.001) which highlighted the vital importance of comprehension problems.

Model Fit Measures

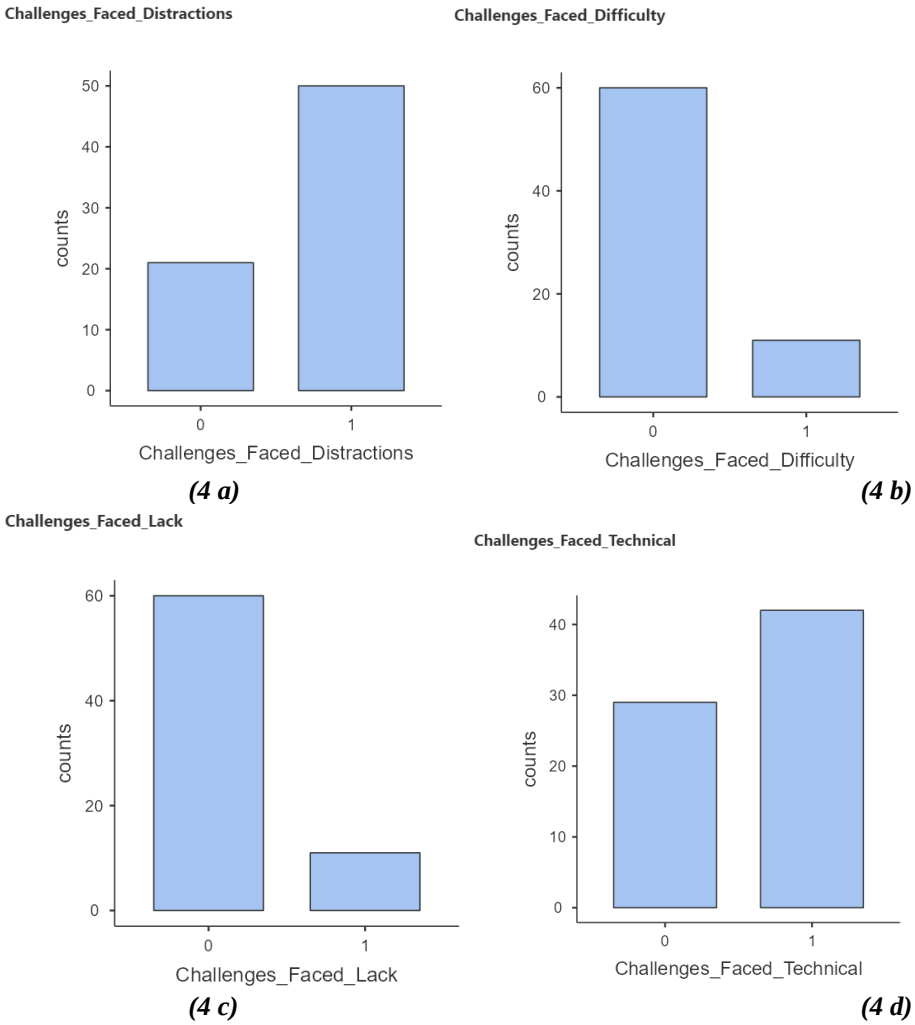
Model	R	R^2
1	0.437	0.191

Model Coefficients - Engagement_Level

Predictor	Estimate	SE	t	p
Intercept	3.3746	0.272	12.4214	< .001
Challenges_Faced_Distractions	0.2208	0.229	0.9623	0.339
Challenges_Faced_Difficulty	−0.9147	0.272	−3.3672	0.001
Challenges_Faced_Technical	0.3270	0.202	1.6226	0.109
Challenges_Faced_Lack	−0.0284	0.293	−0.0969	0.923

Table 9: Regression Analysis of Objective 4

A stacked bar chart (Figure 4) illustrates the frequency of reported challenges, with distractions being the most significant barrier to engagement.



(4 a) ***(4 b)*** ***(4 c)*** ***(4 d)***

Figure 4: Challenges faced by students in digital learning environments

Hypothesis Testing:

Alternate Hypothesis (A_4): Challenges in digital learning significantly affect student engagement.

Result: Accepted. Challenges such as distractions, technical difficulties, and lack of teacher support significantly hindered engagement, necessitating targeted interventions to improve learning outcomes.

The study identifies the need to resolve structural network connectivity and device availability hurdles in rural communities specifically. To enhance focus the establishment of structured learning spaces and additional technical aid can reduce interruptions caused by distractions.

DISCUSSION

The research results prove student engagement depends on digital resources and teacher assistance but produces proprietary knowledge which advances current scholarly findings. AI-powered academic tools such as gamification alongside personalized feedback elevates both learning behavior and cognitive engagement; however, continued extensive use results in digital tiredness. The researchers support Ahmed et al. (2023) by emphasizing how digital learning moderation remains essential for digital educational contexts. This research builds upon previous studies by measuring the adverse student engagement effects that result from excessive tool usage through cognitive content congestion related to interactive software.

Research findings indicate that teacher support acts as an essential element for maintaining students' emotional as well as motivational involvement. Results from Xia et al. (2023) show that teacher-student relations serve to develop trust and motivation in educational environments. This current study establishes that students need regular assessment support and educational guidance provided by teachers to overcome automated systems' shortcomings in emotional connection requirements.

An evaluation of challenges in internet connectivity and digital distractions demonstrates the pressing need for infrastructure improvements throughout Indian rural locations. The approach presented by this study distinguishes itself from research that concentrates exclusively on technology development (Kurniawan et al., 2024) because it demonstrates how human support combines with technological integration for diverse socio-economic circumstances such as India.

The research extends academic understanding through its

analysis which reveals the requirement of proper blending between digital solutions and human resources for maximizing interaction. This research offers implementable information about how to address and solve both organizational issues and teacher skills gaps and artificial Intelligence tool management.

CONCLUSION AND RECOMMENDATIONS

Conclusion:

A systematic evaluation studies the way digital transformation and teacher support collaboration influences student engagement throughout the Indian EdTech system. The findings establish student engagement exists in multiple dimensions which need both technological elements along with human contact.

AI tools, particularly gamification and personalized feedback, contribute positively to student engagement by making learning interactive. However, overuse can lead to digital fatigue and disengagement, requiring a balanced integration with traditional learning methods. Support from teachers plays a crucial role in engagement. However, statistical findings indicate that while teacher support has a positive correlation with engagement, its significance was limited, suggesting that multiple factors contribute to sustained digital learning participation.

A number of obstacles including digital burnout and insufficient infrastructure and minimal teaching staff participation across rural settings means digital learning approaches experience reduced effectiveness. These educational obstacles can be resolved by distributing resources fairly as well as conducting specialized teaching programs which will boost student outcomes

The examination demonstrates that educational institutions require blended learning techniques that unite technological resources with human educator involvement. Stakeholders should tackle infrastructure constraints and enhance digital access beside training teachers effectively to build inclusive virtual educational settings which serve diverse Indian student requirements.

Recommendations:

Enhanced Teacher Training:

- *The training should integrate with yearly professional practice activities to help teachers develop suitable digital teaching abilities.*
- *Teacher professional development should demonstrate methods to combine technological resources with traditional instructional approaches to create positive educational experiences.*

Strategic Use of AI-Powered Tools:

- *Additional use of artificial intelligence tools which include gamification systems and feedback analytics should supplement established teaching methods yet should not substitute them.*
- *The effectiveness of implemented tools should be quantitatively evaluated for quality improvement instead of disengagement reduction among students.*

Improvement of Digital Infrastructure:

- *Policy makers are tasked with building infrastructure that enables internet connectivity combined with devices for rural areas along with inaccessible regions.*
- *The private sector collaboration should complete essential system gaps to create equal technological access.*

Interactive and Adaptive Learning Content:

- *Learning content needs to adopt diverse presentation formats suited for learners with different abilities including visual audio materials that illustrate theories through real-life examples.*
- *Creating effective content involves eliminating large quantities of learning material and tasks which disrupt student engagement.*

Strengthening Teacher-Student Communication:

- *Online mentoring initiatives paired with live classes and feedback networks need expansion to deepen the connection between teachers and students.*
- *Systematic evaluation of classroom interactions helps close emotional participation gaps while building student awareness of feeling part of their educational environment.*

Addressing Digital Learning Challenges:

- *Educational institutions need to implement strategies that reduce digital learning distractions and interference by optimizing study schedules and minimizing non-academic interruptions.*
- *Students will succeed better with digital strategies for managing stress as well as digital connection improvements when facing the challenges of online learning.*

Future Research Directions

- Longitudinal research must investigate how academic performance maintains its level when teacher support joins forces with artificial intelligence tools.
- The evaluation of diverse EdTech platforms through comparison research reveals preferred techniques to enhance student engagement.
- Evaluators should study whether blended learning strategies adapt well to demographically different educational settings.
- Digital transformation initiatives experience varying degrees of success because cultural background and socioeconomic factors influence their results.
- Integration of the proposed recommendations enables educators together with policymakers and EdTech companies to develop effective digital learning atmospheres which provide engaging and

inclusive learner experiences for students with different needs.

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