

Relationship between Digital Learning, Digital Literacy and Academic Performance of Higher Education Students: Moderated Mediation Role of Critical Thinking

Ravikumar T^{1*}, Raghunandan G², John Benedict D², Vinita Seshadri¹,
Abhinandan N³

¹School of Business and Management, CHRIST (Deemed University), Bangalore - 560029, Karnataka, India, ²School of Commerce, Finance and Accountancy, CHRIST (Deemed University), CHRIST (Deemed University), Bangalore - 560029, Karnataka, India, ³Commerce, Maharani Lakshmi Ammani College for Women, Malleshwaram, Karnataka, India. *Corresponding Author's Email: ravikumar.t@christuniversity.in

Abstract

In today's rapidly evolving educational landscape, digital technologies have become increasingly prevalent, transforming how students access and engage with information. This study explores the relationships among digital learning, digital literacy, and academic performance in higher education, focusing on the moderating and mediating role of critical thinking. The adoption of digital learning platforms, such as online courses and virtual classrooms, has expanded educational access and flexibility. However, concerns regarding their effectiveness persist. Digital literacy, encompassing the ability to navigate digital tools and critically evaluate information, is crucial in this context. This research investigates how students' digital literacy levels influence their academic achievement and examines the mediating role of critical thinking in this relationship. Critical thinking is hypothesized to mediate the effects of digital literacy on academic performance and the impact of digital learning on critical thinking skills. Additionally, the study assesses whether critical thinking moderates the prime relationship between digital learning and academic performance. This descriptive, cross-sectional study employs structured questionnaires to gather primary data from 384 students enrolled in undergraduate, postgraduate, professional, and research programs at private universities in Bangalore, India. The findings indicate that the academic program significantly influences students' perceptions of digital literacy, digital learning, critical thinking, and academic performance, while demographic factors do not. Digital learning alone has a slight negative effect on academic performance, but digital literacy acts as a positive mediator, mitigating this impact. However, critical thinking does not significantly moderate the relationship between digital learning and academic performance.

Keywords: Academic Performance, Critical Thinking, Digital Learning, Digital Literacy.

Introduction

In today's rapidly evolving educational landscape, integrating digital technologies has become increasingly prevalent, transforming how students access and engage with information. The emergence of digital learning environments has not only revolutionized the delivery of education but also raised questions about their impact on student's academic performance. This study delves into the intricate interplay among three pivotal factors in higher education: digital learning, digital literacy, and academic performance focusing on the moderating and mediating role of critical thinking. The widespread adoption of digital learning platforms, ranging from online courses to virtual classrooms, has created an unprecedented opportunity for higher education institutions to

extend their reach and provide flexible learning options. However, alongside the promises of increased accessibility and convenience, concerns have arisen regarding their effectiveness and the extent to which they enhance or hinder students' performance.

Digital literacy, on the other hand, has become an essential skill set for today's students, encompassing the ability to navigate digital tools, critically evaluate online information, and communicate effectively in digital formats. Understanding how students' digital literacy levels influence their academic achievement is of paramount importance in an era where information is primarily accessed through digital means. Additionally, this research investigates

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(Received 01st May 2024; Accepted 20th July 2024; Published 30th July 2024)

how critical thinking serves as a mediator in connecting digital learning, digital literacy, and academic performance. Critical thinking, a crucial cognitive ability, empowers individuals to proficiently analyze, assess, and integrate information. It is hypothesized that critical thinking may serve as a mediator, explaining how digital literacy influences academic performance and how digital learning experiences impact critical thinking abilities. Furthermore, this study examines the moderating impacts of critical thinking, assessing whether its influence strengthens or weakens the connection between digital learning and academic performance. It is posited that higher levels of critical thinking may amplify the benefits of digital learning experiences, ultimately leading to improved academic outcomes.

As educational institutions increasingly adopt digital learning tools and platforms, this study clarifies the direct impact these tools have on academic performance. It offers empirical evidence on the effectiveness of digital learning, helping educators refine their digital strategies. Digital literacy, which involves the proficient use of digital tools and resources, is essential for student success in a tech-driven educational setting. The study emphasizes the critical role of digital literacy, demonstrating how it serves as a foundational skill that enhances students' ability to effectively navigate and use digital learning resources. Additionally, the study presents critical thinking as both a mediator and a moderator in the relationship between digital competencies and academic performance. This underscores the nuanced role of critical thinking, indicating that while digital literacy and learning tools are vital, the capacity to critically assess and apply information is what truly improves academic outcomes. Thus, this study is crucial for understanding how digital competencies influence student achievements in higher education. It provides a comprehensive framework that highlights the importance of digital literacy and critical thinking, offering practical insights for educators, policymakers, and students aiming to excel in a digital learning environment.

The objective of this study is to provide valuable perspectives on the complicated relationship of digital learning, digital literacy, and critical thinking in higher education. Through a thorough

examination of these interconnected elements, the research aims to provide insights that can guide educators, institutions, and policymakers in leveraging digital technologies to enhance the learning environment and foster academic achievement among higher education students. In the context of rapidly evolving digital technologies and educational methods, this study is timely. It helps higher education institutions understand the critical factors that contribute to student success in a digital age, enabling them to adapt more effectively to these changes.

Bloom's Taxonomy classifies cognitive skills into six tiers: remembering, understanding, applying, analyzing, evaluating, and creating. Higher-order thinking skills like analyzing, evaluating, and creating are essential for critical thinking. This framework aids in cultivating critical thinking by guiding educators to create learning activities that foster these advanced cognitive skills. Constructivist theory theorizes that learners construct their own understanding and knowledge through experiences and reflecting on those experiences. This approach encourages active learning and critical thinking, as students are required to question, analyze, and synthesize information rather than passively receive it. Information processing theory explains how humans process, store, and retrieve information. Critical thinking is enhanced by understanding how to effectively organize and use information. Educators can design instructional strategies that help students' process information more deeply, leading to better critical thinking skills. Richard Paul and Linda Elder's framework outlines the elements of thought (purpose, question, information, interpretation, concepts, assumptions, implications, and point of view) and intellectual standards (clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness) necessary for critical thinking. This structured approach helps educators teach and assess critical thinking skills.

A review of the extant literature works intends to figure out the contributions of various research works in the fields of digital learning, digital literacy, critical thinking, and academic performance. Digital learning, often referred to as e-learning, has gained significant prominence in higher education. It includes a broad spectrum of educational approaches that utilize digital

technologies and the internet to deliver and enhance learning experiences. It encompasses a wide range of educational activities facilitated by digital technologies, including online courses, virtual classrooms, and blended learning approaches. Numerous studies have explored the impact of digital learning on student performance (1–4). Research indicates that when implemented effectively, digital learning can enhance student engagement, flexibility, and access to educational resources, leading to improved academic outcomes (5–7). In contemporary education, digital learning is increasingly gaining popularity. Traditional classroom setups have transitioned to online formats, ranging from fully digital courses to remotely conducted classes (1). But, the extent to which digital learning influences student performance varies and depends on various factors, including the quality of instructional design, learner characteristics, and the specific context of use. While the significance of digital educational platforms is undeniable, developing countries encounter various challenges and uncertainties. These issues are linked to factors such as the delivery method, variations in group motivation, and the formulation of teaching methods, both in face-to-face and offline class settings (8). Digital learning has the potential to enhance students' critical thinking skills, but it also comes with various challenges related to sociocultural factors, students' prior learning habits, and their familiarity with up-to-date technology for educational purposes (4). The students' views on the effectiveness of online learning systems exhibited a substantial improvement. Furthermore, the study revealed a noteworthy enhancement in the creativity of the students (9). The educational process should align with technological advancements, making it imperative to harness the full potential of E-Learning. In the context of 21st-century learning challenges, students must possess critical thinking skills and digital literacy as essential competencies (7). Digital learning has become a fundamental part of contemporary education. Its accessibility, flexibility, and adaptability make it a valuable tool for learners of all ages and backgrounds. While challenges persist, ongoing advancements in technology and pedagogy are likely to continue reshaping the landscape of education, with digital

learning playing a central role in the future of learning and skill development.

Hypothesis 1: The academic performance of higher education students in India does not show a significant impact from digital learning.

Digital literacy comprises a multifaceted skill set that involves the effective navigation, evaluation, and creation of digital content. In today's information-driven world, digital literacy is crucial for students to thrive academically and in their future careers. Studies have shown that digital literacy skilled students tend to be more self-sufficient learners, capable of critically assessing online information, and are better equipped to leverage digital tools for their educational benefit. A strong foundation in digital literacy can contribute positively to student performance in higher education (6, 10, 11). Student and teacher engagement are influenced by various factors, with digital literacy being among them (12). Previous research suggests that a strong level of digital literacy and the ability to self-regulate tend to lead to improved academic performance and increased motivation for learning (6). The literature on digital literacy underscores its critical importance in contemporary society. As digital technologies continue to evolve, digital literacy will remain a dynamic and evolving field, requiring ongoing research, education, and policy efforts to ensure that individuals are equipped with the skills and knowledge needed to thrive in the digital age (11, 13, 14).

Hypothesis 2: Digital literacy does not serve as a significant mediating factor in the relationship between digital learning and academic performance in India.

Critical thinking is a fundamental cognitive skill that holds a central role in higher education. It encompasses the capacity to critically analyze information, assess arguments, and make well-reasoned decisions (15). The cultivation of critical thinking skills is regarded as a crucial outcome of higher education, as it provides students with the ability to tackle intricate problems and engage in critical analysis across diverse domains. Studies have shown a positive correlation between critical thinking skills and academic success, as students demonstrating higher levels of critical thinking tend to achieve better grades and exhibit a more profound understanding of the subject matter (4, 12, 16–18). In today's society, people have honed

their critical thinking abilities through technology, providing them with greater opportunities for deep thought and analysis (16). Engaging in eLearning has a noteworthy influence on enhancing students' critical thinking abilities (7). Students across all academic levels stand to gain significant advantages from curricula that emphasize the incorporation of critical thinking strategies and practical application. Those who attain mastery in critical and insightful thinking will not only excel academically in their current high school environment but will also be well-prepared to meet the demanding academic standards and increased expectations encountered in college (19). Students' feedback highlighting the challenge of limited interaction with friends during online learning underscores a potential obstacle to fostering critical thinking skills. Online learning typically involves five interaction types. First is Learner-Interface Interaction, allowing students to access learning information online, second is Learner-Self Interaction, enabling self-monitoring of learning progress through reflection facilitated by online tools, third is Learner-Content Interaction, providing access to learning materials in the online environment and fourth is Learner-Instructor Interaction, allowing students to engage with instructors via online platforms. Lastly, Learner-Learner Interaction involves students interacting with peers in the online learning community. Among these, learner-learner interaction appears to have a more significant impact on learning outcomes compared to the other types (3). Integrating critical thinking into an online learning environment represents a comprehensive approach to modern education. The skills associated with critical thinking are increasingly valuable in the context of today's globalized era. In higher education institutions, educators actively promote the values, concepts, and behaviors associated with critical thinking. Additionally, the pervasive influence of technology, particularly online learning, significantly shapes various facets of teaching and learning. Regardless of educators' preferences, proficiency in technology has become imperative. Online learning has demonstrated its efficacy in

enhancing students' critical thinking skills. However, the practical application of this approach poses challenges for educational professionals (4).

Hypothesis 3: Critical thinking does not play a significant moderating role in influencing the relationship between digital learning and the academic performance of students in India.

Hypothesis 4: Critical thinking does not significantly moderate the mediating role of digital literacy in the relationship between digital learning and the academic performance of students in India.

The concepts of mediation and moderation are frequently employed in educational research to understand the complex relationships between variables. Mediation analysis explores the mechanisms through which one variable influences another, providing insights into the underlying processes. In the framework of this study, it is essential to comprehend the mediation process of digital literacy in the relationship between digital learning and student performance, with a particular emphasis on the potential role of critical thinking in this mediation. The moderating role of critical thinking in the relationship between digital learning and student performance is an area of growing interest. Some studies suggest that students with higher critical thinking skills may benefit more from digital learning environments, as they are better equipped to navigate and engage with the content effectively. However, the extent to which critical thinking moderates this relationship remains a topic of investigation. Overall, the literature suggests that the relationship between digital learning, digital literacy, and student performance in higher education is multifaceted and influenced by various factors. Critical thinking emerges as a potential mediator and moderator in this relationship, highlighting the need for further empirical research to elucidate the intricate dynamics among these variables. Understanding these relationships is crucial for educators and institutions seeking to optimize digital learning experiences and improve student outcomes in higher education settings. The proposed research model is given below (Figure 1).

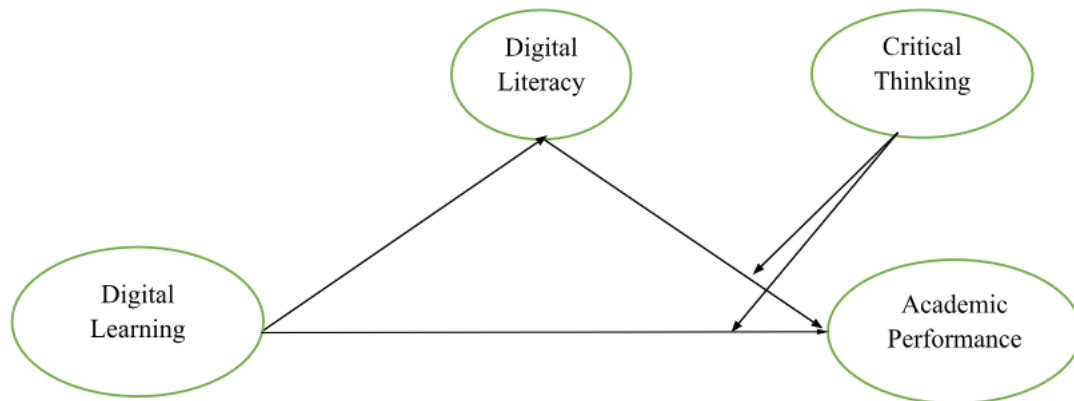


Figure 1: Research Model

Methodology

Research Design

This research study is primarily descriptive, aiming to provide an overview of a certain phenomenon. In contrast, an investigative study typically delves into causal relationships. The study employs a cross-sectional time horizon, meaning data is collected at a single point in time rather than over an extended period. The primary data for this study was gathered using structured questionnaires, utilizing a survey method as the chosen research approach. The focus of analysis encompasses students enrolled in undergraduate, postgraduate, professional, and research programs at private universities located in Bangalore, India. Private universities in this context refer to higher education institutions that are not government-owned but are instead owned and operated by private trusts, societies, or companies, including those designated as "deemed to be universities." Notably, Bangalore has 16 private universities covering various disciplines, including arts, science, engineering, management, and medical fields.

Sampling Framework

The population for this study comprises higher education students in India, while the target population narrows down to higher education students specifically in Bangalore, India. The unit of analysis in this research is the higher education students in Bangalore. Given that the target population is quite substantial, with more than five lakhs (500,000) individuals, the study employs a survey method to collect primary data. To select respondents from this vast population, a judgment sampling technique is utilized. The sample size for this study is determined to be 384 respondents,

and this sample size is chosen with a 95% level of significance, as per Krejcie's (1970) guidelines for determining sample sizes in research studies.

Data Collection

The primary data were collected from the higher education students through a structured questionnaire method. 725 students were approached to collect the data. The data were collected from December 2022 to May 2023. Out of 725 responses, 23 responses were not considered due to incomplete information. 384 responses were considered. The response rate is 56.13%.

Measurement of the Variables

The study involved adapting and customizing measurement scales to suit its specific research objectives and context. Digital Literacy is measured by adopting and customizing the scale of Bayrakci and Narmanlioglu (20) which has 23 items. Online learning has been measured by the Online Learning Self-efficacy Scale (OLSES) of Zimmerman (2016) which has 3 dimensions such as online learning (ten items), time management (four items), and technology usage (seven items). In total, the OLSES scale has 21 items. Critical thinking is measured by the scale of Sarigoz (21) which has 21 items on a five-point scale. Academic Performance is measured by the scale of Abbas et al., (22) (9 items).

Preliminary Study

After designing the questionnaire, it was administered to the higher education students to have a preliminary survey. Based on the data collected in the preliminary survey, the reliability of the variables was checked. The reliability results (alpha scores) are 0.938, 0.828, 0.867, and 0.857 for digital literacy, digital learning, critical thinking, and academic performance. Since the

alpha scores are satisfactory (more than 0.700), the main study was conducted.

Results

Following the main study, the gathered data underwent a cleaning process and was subjected to checks for normality. The results of these normality tests reveal that digital literacy, digital learning, critical thinking, and academic performance do not exhibit a normal distribution. Here are the demographic characteristics of the sampled students: 65.4% of the students are male, while 34.6% are female. The majority, 77.9%, fall within the age group of 17 to 24 years. 19.5% of the students are aged between 25 and 35 years, and 2.6% are older than 35 years. Regarding their academic pursuits, 71.1% are enrolled in undergraduate programs, 18.6% in postgraduate

studies, and 10.3% in research programs. In terms of educational institutions, 78.4% of the sample students study in private institutions, with 21.6% attending government institutions. Geographically, 82% of the institutions are situated in urban areas, while the remaining 18% are located in rural settings. When it comes to academic disciplines, 34.6% of the students are pursuing commerce and management, 24.6% are in humanities, 16.9% are enrolled in professional programs like engineering and medicine, 11.5% are in the field of Science, and 10.9% are in Social Science.

Differences in perceptions of digital literacy, digital learning, critical thinking, and academic performance are analyzed and presented using non-parametric tests such as the Mann-Whitney U Test and the Kruskal-Wallis Test.

Table 1: Changes in Perceptions of Digital Literacy

Factors	P-value	Result
Gender	0.809	No variance exists
Age	0.231	No variance exists
Education	0.091	No variance exists
Nature of Educational Institution	0.941	No variance exists
Program of the Study	0.000	Variance exists
Location	0.887	No variance exists

Table 1 presents the results of a statistical analysis that examines the changes in perceptions of digital literacy across various factors. The p-value for gender is 0.809, surpassing the conventional significance level of 0.05 (5%). This outcome indicates that there is no difference in perceptions of digital literacy between individuals of different genders. In other words, gender does not seem to influence how individuals perceive their digital literacy skills. Similarly, the p-value for age is 0.231, which is also greater than 0.05. This indicates that age does not have a statistically significant impact on perceptions of digital literacy. The p-value for education is 0.091, which is close to the significance level. This suggests that there might be a weak or borderline significant effect of education on perceptions of digital literacy, but it's not strong enough to conclude that a significant variance exists. The p-value for the nature of the educational institution is 0.941, which is much greater than 0.05. This indicates that the type of educational institution (private or government) does not have a statistically significant impact on perceptions of digital

literacy. The p-value for the program of study is 0.000, which is less than 0.05. This result suggests that there is a difference in perceptions of digital literacy based on the program of study. In other words, the choice of academic program does influence how individuals perceive their digital literacy skills. The p-value for location is 0.887, which is greater than 0.05. This means that the location (urban or rural) of the educational institution does not have a statistically significant impact on perceptions of digital literacy. The results indicate that the program of study is the only factor among those analyzed that significantly influences perceptions of digital literacy. The other factors, including gender, age, education level, nature of the educational institution, and location, do not exhibit significant variance in how individuals perceive their digital literacy skills.

Table 2 presents the results of a statistical analysis of changes in perceptions of digital learning across various factors. This result suggests that there is no significant difference in perceptions of digital learning between different genders. Gender does not seem to influence how individuals perceive

digital learning. Similarly, the p-value for age is 0.984, which is also greater than 0.05. This indicates that age does not have a statistically significant impact on perceptions of digital learning. The p-value for education is 0.891, which is much greater than 0.05. This suggests that there is no significant difference in perceptions of digital learning based on education level. The p-value for the nature of the educational institution is 0.743, which is greater than 0.05. This means that the type of educational institution (private or government) does not have a statistically significant impact on perceptions of digital learning. The p-value for the program of study is 0.000. This result indicates that there is a significant difference in perceptions of digital learning based on the program of study. In other words, the choice of academic program does influence how individuals perceive digital learning. The p-value for location is 0.579. This means that

the location (urban or rural) of the educational institution does not have a significant impact on perceptions of digital learning. In summary, similar to perceptions of digital literacy, the program of study is the only factor among those analyzed that significantly influences perceptions of digital learning. The other factors, including gender, age, education level, nature of the educational institution, and location, do not exhibit significant variance in how individuals perceive digital learning.

Table 3 results convey that similar to perceptions of digital literacy and digital learning, the program of study is the only factor among those analyzed that significantly influences perceptions of critical thinking. The other factors, including gender, age, education level, nature of the educational institution, and location, do not exhibit significant variance in how individuals perceive their critical thinking abilities.

Table 2: Changes in Perceptions of Digital Learning

Factors	P-value	Result
Gender	0.670	No variance exists
Age	0.984	No variance exists
Education	0.891	No variance exists
Nature of Educational Institution	0.743	No variance exists
Program of the Study	0.000	Variance exists
Location	0.579	No variance exists

Table 3: Changes in Perceptions of Critical Thinking

Factors	P-value	Result
Gender	0.599	No variance exists
Age	0.594	No variance exists
Education	0.227	No variance exists
Nature of Educational Institution	0.855	No variance exists
Program of the Study	0.000	Variance exists
Location	0.598	No variance exists

Table 4: Changes in Perceptions of Academic Performance

Factors	P-value	Result
Gender	0.280	No variance exists
Age	0.158	No variance exists
Education	0.155	No variance exists
Nature of Educational Institution	0.913	No variance exists
Program of the Study	0.000	Variance exists
Location	0.765	No variance exists

Table 5: Correlation - Kendall's Tau

Particulars	Digital Literacy	Digital Learning	Critical Thinking	Academic Performance
Digital Literacy	1			
Digital Learning	0.398	1		

Critical Thinking	0.615	0.538	1	
Academic Performance	0.787	0.348	0.534	1

Similar to perceptions of critical thinking, the program of study is the only factor among those analyzed that significantly influences perceptions of academic performance. The other factors, including gender, age, education level, nature of the educational institution, and location, do not exhibit significant variance in how individuals perceive their academic performance (Table 4).

Relationships between perceptions of digital literacy, digital learning, critical thinking, and academic performance are analyzed and presented using the non-parametric correlation test Kendall's Tau (Table 5).

The correlation results, calculated using Kendall's Tau correlation coefficient, provide insights into the relationships between the variables of Digital Literacy, Digital Learning, Critical Thinking, and Academic Performance. There is a moderate positive correlation (0.398) between Digital Literacy and Digital Learning. This suggests that individuals who perceive themselves as having higher digital literacy skills are also more likely to have positive perceptions of their digital learning experiences. A moderate positive correlation (0.615) exists between Digital Literacy and Critical Thinking. This implies that individuals who believe they possess higher digital literacy skills also tend to have more positive perceptions of their critical thinking abilities. A strong positive correlation (0.787) lies between Digital Literacy and Academic Performance. This indicates that individuals who perceive themselves as having stronger digital literacy skills are more likely to have positive perceptions of their academic performance. A moderate positive correlation (0.538) lies between Digital Learning and Critical Thinking. This suggests that those who have positive views of their digital learning experiences are also more likely to have positive perceptions of their critical thinking abilities. There is a weak positive correlation (0.348) between Digital Learning and Academic Performance. This implies that individuals with more positive perceptions of their digital learning experiences also tend to have

slightly more positive perceptions of their academic performance. A moderate positive correlation (0.534) between Critical Thinking and Academic Performance. This indicates that individuals who believe they possess strong critical thinking abilities also tend to have more positive perceptions of their academic performance.

These correlation results suggest that there are meaningful relationships between these variables. Higher perceptions of Digital Literacy are associated with higher perceptions of Digital Learning, Critical Thinking, and Academic Performance. Similarly, positive perceptions of Digital Learning are correlated with more positive perceptions of Critical Thinking and Academic Performance. Finally, individuals with high perceptions of Critical Thinking tend to also have higher perceptions of Academic Performance. These correlations provide insights into how these aspects are interconnected in the context of the study.

Next, the study assesses the influence of digital learning on the academic performance of higher education students and examines the mediating role of digital literacy in the relationship between digital learning and academic performance. This analysis is conducted using the Process Macro (Model 7), and the results are presented below.

Tables 6 and 7 display the influence of digital learning on the mediator, which is Digital literacy, and the overall fit of the model. The model fit is noteworthy as shown in Table 6. There is a significant impact of digital learning on digital literacy with a p-value of 0.000. Furthermore, digital learning accounts for 32.91% of the variation in the digital literacy of the sampled students.

Tables 8 and 9 highlight the mediating role of the model. As indicated in Table 8, the model is of significance. Digital learning and digital literacy together account for 87.79% of the variation in students' academic performance.

Table 6: Model Outline

r	r²	MSE	F	P
0.5736	0.3291	0.3157	187.3615	0.000

Outcome variable: Digital Literacy

Table 7: Model

Particulars	Coefficients	SE	t	P
Constant	1.1702	0.1833	06.3843	0.000
Digital Learning	0.7490	0.0547	13.6880	0.000

Outcome variable: Digital Literacy

Table 8: Model Outline

r	r ²	MSE	F	P
0.9370	0.8779	0.0649	1370.2264	0.000

Outcome variable: Academic Performance

Table 9: Model

Particulars	Coefficients	SE	t	P
Constant	0.1562	0.0874	1.7874	0.000
Digital Learning	-.0646	0.0303	-2.1341	0.033
Digital Literacy	1.0221	0.0232	44.0680	0.000

Outcome variable: Academic Performance

Table 10: Direct Effect

Effect	SE	t	P
-.0646	0.0303	-2.1341	0.033

Table 9 demonstrates the influence of both digital learning and digital literacy on the academic achievements of the sampled students. Both factors notably impact the student's academic performance, with a p-value of 0.000. Therefore, the indirect impacts from digital learning to digital literacy (as presented in Table 7) and from digital literacy to academic performance (as indicated in Table 9) are significant.

The relationship between digital learning and academic performance holds great importance, and this connection is characterized by a negative impact of 6.4% as shown in Table 10. The comprehensive indirect impact is detailed in Table 11, where it's revealed that digital literacy plays a substantial role in the relationship between digital

learning and academic performance, accounting for 76.56% of the total effect. This indirect relationship is statistically significant since there is no occurrence of zero between the "Boot Lower Limit of Confidence Interval (Boot LLCI)" and "Boot Upper Limit of Confidence Interval (Boot ULCI)." It's worth noting that digital learning has a direct negative influence on academic performance, but when digital literacy comes into play, it significantly enhances students' academic performance.

Thus, direct relation and mediation are significant in the chosen model. So, hypotheses 1 and 2 are rejected. Further, the moderating role of critical thinking has been analyzed using Process Model 15. The results are presented here.

Table 11: Indirect Effect

Mediator	Effect	BootSE	BootLLCI	BootULCI
Digital Literacy	0.7656	0.0598	0.6511	0.8868

Table 12: Model Outline

r	r ²	MSE	F	P
0.9383	0.8804	0.0641	556.4819	0.000

Outcome variable: Academic Performance

Tables 12 and 13 highlight the mediating and moderating roles of digital literacy and critical thinking respectively. As provided in Table 12, the model is of significance. Digital learning, digital literacy, and critical thinking together account for 88.04% of the variation in students' academic performance.

Table 13 demonstrates the influence of digital learning, digital literacy, and critical thinking on the academic achievements of the sampled students. The impact of digital learning on the academic performance of the students has become insignificant (P-value: 0.163). Interaction 1 and

Interaction 2 are not significant. So, moderation effects are also not significant.

Table 14 reveals that moderated mediation of critical thinking is not significant as there is no

occurrence of zero between the "Boot Lower Limit of Confidence Interval (Boot LLCI)" and "Boot Upper Limit of Confidence Interval (Boot ULCI)." So, hypotheses 3 and 4 are accepted.

Table 13: Model

Particulars	Coefficients	SE	t	P
Constant	0.8246	0.4527	1.8216	0.006
Digital Learning	-.2615	0.1874	-1.3956	0.163
Digital Literacy	1.1287	0.1433	7.8749	0.000
Cric_T	-.2817	0.1374	-2.0499	0.041
Interaction 1 (Digital Learning X Cric_T)	0.0652	0.0497	1.3106	0.190
Interaction 2 (Digital Literacy X Cric_T)	-.0135	0.0395	-.3430	0.731

Outcome variable: Academic Performance

Table 14: Index of Moderated Mediation

Particulars	Index	BootSE	BLLCI	ULLCI
Cric_T	-.0101	0.0289	-.0632	0.0515

Outcome variable: Academic Performance

Discussions

The findings of the study, which investigates the influence of digital learning on the academic performance of higher education students in India while considering the mediating role of digital literacy and the moderating role of critical thinking, uncover several noteworthy results outlined below. The program of study appears to be the primary factor influencing how students perceive their digital literacy skills. In contrast, demographic factors such as gender, age, education level, the type of educational institution attended, and location do not significantly affect students' perceptions of their digital literacy. This suggests that the academic program students are enrolled in has a more pronounced impact on their digital literacy perceptions than other personal characteristics or contextual factors. Similar to digital literacy, the program of study stands out as the most influential factor in shaping students' perceptions of digital learning. Again, gender, age, education level, the nature of the educational institution, and location do not significantly impact how students perceive their digital learning experiences. This reinforces the notion that the academic program plays a central role in shaping these perceptions. The program of study also significantly affects how students perceive their critical thinking abilities. Once more, demographic and contextual factors such as gender, age, education level, institution type, and location do not show significant variations in students' views of their critical thinking skills. The academic

program appears to be the dominant factor in influencing critical thinking perceptions among students. Consistent with the previous findings, the program of study emerges as the primary factor influencing students' perceptions of their academic performance. Gender, age, education level, institutional characteristics, and location do not significantly impact how students perceive their academic achievements. This underscores the prominence of the academic program in shaping students' perceptions in this domain. Furthermore, the study identifies a negative impact of 6.4% in the relationship between digital learning and academic performance. This indicates that digital learning, in isolation, has a slightly adverse effect on the academic performance of the sampled students.

Nevertheless, when accounting for the indirect effects, the study unveils a significant mediating role of digital literacy in the relationship between digital learning and academic performance. Digital literacy accounts for 76.56% of the total effect, indicating that it acts as a positive mediator, alleviating the negative impact of digital learning on academic performance. Importantly, this indirect relationship is statistically significant.

Moreover, the study investigates moderation effects, specifically examining the role of critical thinking as a moderator. However, the results indicate that neither the impact of digital learning nor the moderation effects of critical thinking are significant for academic performance. This suggests that critical thinking does not

significantly moderate the relationship between digital learning and academic performance in this context. The study underscores the significant influence of the academic program on students' perceptions of digital literacy, digital learning, critical thinking, and academic performance. It also highlights the complex interplay between these factors, indicating that while digital learning alone may have a negative impact on academic performance, digital literacy serves as a substantial mediator in mitigating this effect. However, critical thinking does not appear to play a significant moderating role in this relationship. Overall, while the academic program plays a crucial role in shaping critical thinking perceptions, the study suggests that critical thinking does not significantly affect the relationship between digital learning and academic performance. This highlights the complexity of the relationship between digital learning, digital literacy, and critical thinking, and underscores the importance of the academic program in influencing student outcomes.

Conclusion

This study has provided valuable insights into the interplay between digital learning, digital literacy, critical thinking, and academic performance among higher education students in India. The academic program of study stands out as the primary factor influencing how students perceive their digital literacy skills. Demographic factors such as gender, age, education level, institution type, and location do not significantly impact these perceptions, underscoring the dominant role of the academic program. Similarly, the academic program of study significantly shapes students' perceptions of digital learning, while other demographic and contextual factors do not exert significant influence. Once again, the academic program of study is the major factor affecting students' views of their critical thinking abilities, with demographic and contextual factors showing limited impact. The program of study remains the most influential factor in determining how students perceive their academic performance, with demographic and contextual variables playing a minor role. Additionally, the study has revealed that the direct relationship between digital learning and academic performance is negative, with digital learning having a slightly

adverse impact on academic performance. However, when considering indirect effects, digital literacy emerges as a powerful mediator, accounting for 76.56% of the total effect. This suggests that digital literacy acts as a positive mediator, counterbalancing the negative influence of digital learning on academic performance. Importantly, this mediating role of digital literacy is statistically significant. Furthermore, the study explored the moderation effects of critical thinking but found that neither digital learning nor critical thinking had significant impacts on academic performance. This implies that critical thinking does not significantly moderate the relationship between digital learning and academic performance within this specific context. This study highlights the prominent role of the academic program in shaping students' perceptions of digital literacy, digital learning, critical thinking, and academic performance. It also emphasizes the importance of digital literacy as a mediator, offsetting the negative impact of digital learning on academic performance. However, critical thinking does not appear to play a significant moderating role in this relationship. These findings contribute to our understanding of the dynamics between digital education and academic outcomes among higher education students in India.

Abbreviations

Nil.

Acknowledgement

Nil.

Author Contributions

Conceptualization: Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N; Formal analysis: Ravikumar T; Investigation: Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N; Methodology: Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N; Resources: Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N; Software: Ravikumar T, Raghunandan and Vinita Sheshadri; Supervision: Ravikumar T; Validation: Ravikumar T, Raghunandan G, John Benedict D, and Vinita Sheshadri; Visualization: Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N; Writing – original draft:

Ravikumar T, Raghunandan G, John Benedict D, Vinita Sheshadri and Abhinandan N

Conflict of Interest

The authors have no conflicts of interest to declare.

Ethics Approval

The authors received the consent of the start-up employees to administer the questionnaires from the concerned employees.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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