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The Impact of Generative AI on Academic Performance and Social Sustainability: A PLS-SEM and fsQCA Study

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ABSTRACT

Generative Artificial Intelligence (GenAI) has emerged as an innovative tool that enhances knowledge creation in literary sources and decision making in business analytic.The current study aims to examine the impact of knowledge-based factors on academic performance in narrow context and social sustainability in broad context based on Social Cognitive Theory. Data were collected from 480 Generation Z (Gen Z) respondents using a stratified sampling technique in the Delhi NCR region. The study adopts a mixed-methods approach to empirically validate the four hypotheses. The results using partial least squares structural equation modeling (PLS-SEM) highlighted that knowledge acquisition and knowledge application have a positive impact on GenAI competence. Moreover, GenAI competence also has a positive effect on academic performance and social sustainability. Additionally, the fuzzy-set qualitative comparative analysis (fsQCA) revealed three necessary conditions for validating the SEM results. The advanced AI knowledge encourage the entrepreneurial mindset among students which enhances entrepreneurs ability to identify market trends, and help in taking innovative solutions. Future studies could examine the longitudinal perspective of students to better understand its long-term implications for education and social sustainability.

Keywords: knowledge acquisition, knowledge application, GenAI competence, academic performance, social sustainability

INTRODUCTION

As an AI-powered tool, ChatGPT is transforming educational environments by facilitating multidisciplinary collaboration and providing personalized learning experiences (Al-Mamary et al., 2024). ChatGPT has significantly influenced education and improved student performance (Al Shloul et al., 2024). Among all artificial intelligence tool, Generative AI (GenAI) has emerged as an innovative tool that enhances knowledge creation in literary sources and decision making in business analytic. GenAI refers to the capability of machines to perform tasks that are traditionally associated with human intelligence (Jose et al., 2024). The consumption of GenAI tools is projected to be highest in the United States accounting for 32% (USD 21.65 billion) of the global market share in 2025 (Zhang et al., 2026).

This study addresses a significant gap in understanding the role of GenAI toward social sustainability (Al-Emran et al., 2024). Moreover, this study has also focused on the role of learners perceptions on academic performance (Rizwan et al., 2025). However, the dissemination of knowledge and technological learning enhances the entrepreneurial skill (Gong et al., 2025). Knowledge is a key strategic resource when applied to enhance existing skills (Yang et al., 2025). AI technology acts not only as a tool but also as an active knowledge partner that strengthens knowledge acquisition capabilities (Sun et al., 2025). While, Knowledge management theories focused on organizational contexts only and examining them at the individual level within education can provide deeper insights into learning and academic performance (Alanazi & Curle, 2025).

This study examines the role of knowledge acquisition and its application in determining academic performance and social sustainability. Moreover, GenAI competence act as a mediator of knowledge management and academic performance (Alotaibi, 2025). This study addresses a critical research gap by investigating the combined influence of

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knowledge related factors on educational outcomes which remains unexplored in prior studies (Giannakos et al., 2024; Alsuwaiket, 2026). Grounded in Social Cognitive Theory (SCT) (Bandura, 1999), the study emphasizes the reciprocal interaction between individual capabilities, technological environments, and learning behaviors. SCT has been widely used to explain how environmental and cognitive factors shape student engagement, self-efficacy, and learning outcomes in digital and online learning contexts (Khuhro, 2024; Yalçın & Dennen, 2024). Although, GenAI supports advanced knowledge structuring and personalized learning experiences (Chan & Zhou, 2025). These personalized learning experience strengthen students' academic performance and collaborative learning (Huang et al., 2025; Al-Mamary et al., 2024). In this context, knowledge act as a critical cognitive asset that enables universities to translate GenAI technological potential into tangible academic performance and social sustainability outcomes. Thus, this study aims to achieve the following objectives.

To examine the role of knowledge acquisition and knowledge application on academic performance and social sustainability

LITERATURE REVIEW

Knowledge Acquisition

Knowledge acquisition (KA) refers to the process through which students obtain, apply and integrate knowledge using digital tools and technologies. In entrepreneurship, knowledge serves not only as an input for innovation but also as a catalyst for performance. This transformation not only enhances knowledge accessibility but also improves the efficiency of information transfer. From the Generative AI perspective, acquiring knowledge positively impacts the continued and effective use of chatbots in instructional activities. Furthermore, organizational ICT support acts as a moderating factor to analyse the relationship with knowledge acquisition. Knowledge acquisition also shapes students' subsequent intentions to use digital technologies for learning (Liu et al., 2026). For educators, knowledge acquisition is viewed through the lens of professional development to enhance instructional strategies and teaching effectiveness (Saihi et al., 2025).

Knowledge Application

Knowledge application (KAP) refers to the process by which individuals effectively access, retrieve, and use stored knowledge. University students consistently using GenAI tools to support learning and improve problem-solving skills (Al-Qaysi et al., 2025). Prior research indicates that effective knowledge application positively influences students' adoption of Generative AI (Sherif et al., 2024). Recent studies indicate that knowledge application significantly enhances the decision making capacities among university students (Jo, 2023). Students' application of knowledge gained from AI-based chatbots increases their continued use of these tools for educational purposes (Al-Sharafi et al., 2023).

Consequently, applying knowledge from GenAI tools improves students' proficiency and encourages greater integration of these technologies in academic activities (Al-Emran et al., 2025). Additionally, knowledge application enables students to improve their skills for academic achievement, adaptive learning experiences, and better prediction of educational outcomes. In our study, Knowledge is viewed as an evolving construct shaped through continuous articulation and validation of ideas (Kenett, 2025). From an institutional perspective, knowledge represents a key source of sustainable competitive advantage (Zhang et al., 2024). Effective knowledge management enhances system reliability and institutional performance (AlHyasat & Falahat, 2025). The findings from the literature review indicated that knowledge application positively influences students' use of GenAI (Al-Qaysi et al., 2025).

H1: GenAI competence is significantly influenced by knowledge acquisition

H2: GenAI competence is significantly influenced by knowledge application

GenAI Competence

From a Self Determination Theory (SDT) perspective, GenAI supports learning by satisfying students' needs for autonomy, competence, and relatedness through interactive and adaptive engagement (Gao et al., 2024). In particular, GenAI enhances perceived competence by providing immediate feedback. GenAI competence supports knowledge acquisition, which also strengthens intrinsic motivation among both students and educators (Mendoza et al., 2023; Shahzad et al., 2025). GenAI knowledge competency enhances students' ability to enhance knowledge and skill-set. GenAI competence also enables more effective decision-making for organizational improvement (Al-Mamary, 2025). Empirical evidence shows that integrating GenAI helps in preparing learners to fosters innovation and sustainable skill

development for fulfilling their future need. In practice, many learners develop AI-related competencies through social media, peer networks, and online communities rather than institutional support. Previous study also highlighted the growing role of informal learning ecosystems in shaping holistic digital competence (Gao et al., 2024; Bao et al., 2026).
H3: Academic Performance is significantly influenced by GenAI competence
H4: Social Sustainability is significantly influenced by GenAI competence

Academic performance

Academic performance refers to the students ability to complete their assignments, understand the material, and apply their knowledge to solve problems effectively. In higher education, it is broadly conceptualized to capture educational outcomes relevant to both students and educators. For students, academic performance reflects learning effectiveness, knowledge acquisition, skill development, and the application of acquired knowledge. Prior evidence indicates that digital learning (DL) skills play a significant role in enhancing university students' academic performances. Empirical findings show that informal digital learning plays a significant role in determining academic performance (Ly et al., 2026). Moreover, digital and AI-supported learning tools have emerged as reliable mechanisms for supporting students in completing academic tasks effectively (Crompton & Burke, 2023). Importantly, AI is expected to complement fundamental thinking to support academic performance (Pisica et al., 2023). Academic performance is also closely linked to students overall academic success. Consistent with this perspective, recent studies have confirmed that digital competence has a direct impact on the academic performance of higher education students (Muammar et al., 2025).

Social sustainability

Social sustainability in education promotes fairness, well-being, and community engagement through equitable access to resources, reduction of social inequities, and active community participation (Shehawy et al., 2025). In this context, the integration of technology plays a pivotal role in enhancing social sustainability by fostering inclusive education. Continuous use of GenAI promotes equitable access to learning materials and develops skills that foster social responsibility among learners (Al-Emran, 2023). Moreover, digital technologies help to bridge the gaps by enabling collaboration with other institutions to support broader social sustainability objectives (Abulibdeh et al., 2024). Specifically, the adoption of AI in education enhances social sustainability by providing inclusive and equitable learning opportunities (Al-Emran et al., 2025).
H5: GenAI competence act as a mediator between knowledge acquisition and academic performance
H6: GenAI competence act as a mediator between knowledge application and academic performance
H7: GenAI competence act as a mediator between knowledge acquisition and academic performance
H8: GenAI competence act as a mediator between knowledge application and academic performance

METHODOLOGY

Data Collection and Sampling Technique

The study gathered data through an offline survey questionnaire from 490 respondents belonging to two disciplines, namely Management and Engineering (Gupta & Jaiswal, 2025). Management and engineering students were selected for the study, as they are highly engaged and equipped with the necessary tools and expertise to enhance learning outcomes (Gupta et al., 2024). Only students who were already using GenAI technology were included in the study. A mixed-methods approach was adopted to comprehensively examine the factors influencing both short-term and long-term outcomes related to academic performance and social sustainability (table 1).
Data were collected from 500 Generation Z students using a stratified sampling technique in the Delhi NCR region, of which 480 valid responses were retained for analysis. The demographic profile presented in Table 1 indicates that 57.29% of the respondents were male and 42.71% were female. Regarding age, 27.92% of participants were between 18–20 years, 43.54% were aged 21–23 years, 11.67% were between 24–26 years, and 16.88% were above 26 years. Moreover, the majority of respondents reported using GenAI technology more than four times (table 2) (table 3) (table 4) (table 5) and (table 6).

In this study, internal consistency exceeded 0.8, factor loading were above 0.7, composite reliability (CR) was greater than 0.8, and average variance extracted (AVE) values exceeded 0.6, meeting all recommended thresholds (Hair et al., 2019). In addition, all HTMT values were below 0.85, confirming discriminant validity (Henseler et al., 2015; Shahzad et al., 2025) (figure 1).

Table 1: Respondents details (n=480)

Demographics	Categories	Frequency	%
Gender	Male	275	57.29
	Female	205	42.71
Age	18-20	134	27.92
	21-23	209	43.54
	24-26	56	11.67
	Above 26	81	16.88
Qualification	Bachelor	215	44.79
	Master	156	32.50
	Doctorate	109	22.71
Discipline	Management	290	60.42
	Engineering	190	39.58
Use of GenAI	Minimum Once	115	23.96
	1-2 times	105	21.88
	2-4 times	94	19.58
	More than 4 times	166	34.58

Source(s): Authors' own work

Table 2: Measurement model results (n= 490)

Constructs	FL	α	CR	AVE
Academic Performance		0.918	0.929	0.858
AP1	2.921			
AP2	3.372			
AP3	3.848			
Generative AI Competence		0.735	0.742	0.661
GAIC1	1.174			
GAIC2	2.205			
GAIC3	2.293			
Knowledge Acquisition		0.749	0.743	0.667
KA1	3.127			
KA2	3.023			
KA3	1.153			
Knowledge Application		0.884	0.91	0.81
KAP1	2.812			
KAP2	2.204			
KAP3	2.664			
Social Sustainability		0.923	0.926	0.866
SS1	3.423			
SS2	3.32			
SS3	3.644			

Source(s): Authors' own work

Table 3: Discriminant Validity-Fornell-Larcker criterion

	AP	GAC	KA	KAP	SS
AP	0.926				
GAC	0.345	0.813			
KA	0.317	0.469	0.817		
KAP	0.364	0.307	0.385	0.9	
SS	0.753	0.422	0.401	0.405	0.931

Source(s): Authors' own work

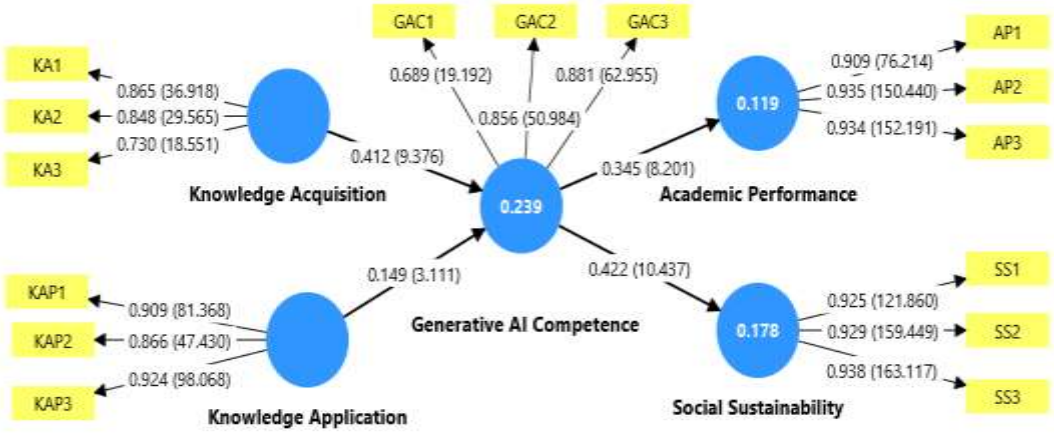

Figure 1: Structural Model

Source(s): Authors' own work

Table 4: Path Coefficient

	β-value	T-values	P-values	Outcomes
GAIC-> AP	0.042	8.201	0	Accepted
GAIC->SS	0.04	10.437	0	Accepted
KA ->GAIC	0.044	9.376	0	Accepted
KAP>GAIC	0.048	3.111	0.002	Accepted

Source(s): Authors' own work

***Table 5*:** Intermediate Solutions

frequency cutoff: 11
consistency cutoff: 0.812862

Paths	KA1	KAP1	GAC1	AP1	SS1	Raw Coverage	Consistency
~KA1*KAP1*SS1	○	●			●	0.276011	0.799263
GAIC1*KAP1*SS1		●	●		●	0.321275	0.816823
~GAIC1*KA1*~KAP1*SS1	●	○	○		●	0.816823	0.083682
solution coverage: 0.523299							
solution consistency: 0.81074							

Source(s): Authors' own work

***Table 6*:** Analysis of Necessary Conditions

	Consistency	**Coverage**
~KA1+KAP1+SS1	0.924803	0.364396
GAIC1+KAP1+SS1	0.912623	0.525177
~GAIC1+KA1+~KAP1+SS1	0.959523	0.347907

Source(s): Authors' own work

CONCLUSION AND DISCUSSIONS

The results provide strong support for the acceptance of the hypotheses. The results demonstrated that knowledge acquisition and knowledge application significantly influence academic performance and social sustainability. The findings indicate that knowledge acquisition act as a mediator of Generative AI use and academic performance (Al-Qaysi et al., 2025). The SEM-PLS analysis revealed path coefficients of β = 0.042 (GAIC → AP), β = 0.040 (GAIC → SS), β = 0.044 (KA → GAIC), and β = 0.048 (KAP → GAIC), all of which were statistically significant. To enhance the reliability of the findings, qualitative methods of fsQCA incorporated to get a more comprehensive understanding of the findings. In addition, fsQCA confirmed the necessity and configuration effects. The intermediate solution with a frequency cutoff of 11 and a consistency threshold of 0.8129 identified three configurations leading to the outcome. The first configuration (~KA1**KAP1*SS1) showed a raw coverage of 0.2760 and consistency of 0.7993. The second configuration (GAIC1**KAP1*SS1) demonstrated a raw coverage of 0.3213 and consistency of 0.8168. The third configuration (~GAIC1**KA1*~KAP1*SS1) yielded a raw coverage of 0.8168 and consistency of 0.8368. Overall, the solution achieved a coverage of 0.5233 and a consistency of 0.8107.

LIMITATIONS AND FUTURE STUDIES

This study used a cross-sectional design to determine the factor influencing academic performance and social sustainability. Future research could consider longitudinal designs to capture the changing sphere of perception of students toward the use of GenAI technology over time. This focus is limited to Indian higher education students belongs to two disciplines only. Future research could explore the perception of various age groups, disciplines, and countries. Additionally, this study has not covered any moderating factors influencing academic performance. Future study could consider different moderating factors such as emotional intelligence, ethical concern and learning styles and its affects on different factors such as employment opportunities, entrepreneurial skills, and other related variables (Alsuwaiket et al., 2026). Future studies could examine how students perceptions change over time to better understand its long-term implications for education and social sustainability (Al-Emran et al., 2025). Additionally, Future research could consider environmental and economic dimensions of Generative AI to develop a more comprehensive understanding of its sustainability.

IMPLICATIONS

This study offers several theoretical contributions. First, it addresses a significant gap by examining the combined effects of AI knowledge acquisition and knowledge application on social sustainability (Alotaibi, 2025; Giannakos *et al*., 2024). The advanced AI knowledge encourage the entrepreneurial mindset among students which enhances entrepreneurs ability to identify market gaps, assess risks, and develop innovative solutions (Al-Mamary, 2025). Moreover, the advanced knowledge enhances entrepreneurs' confidence to continue new business (Al-Mamary, 2025).The findings suggest that knowledge acquisition and application strengthen students' structural knowledge which is essential for entrepreneurial outcomes (Marvi et al., 2025). This study has also suggested various practical contributions. First, universities could develop policies to integrate literary techniques into their curricula according to the specific needs of each discipline. Second, by advancing Digital Literacy, Institutions could evaluate digital AI outcomes, students moral value and skill development (Wang *et al*., 2025). Third, Policymakers could frame AI ethical guidelines at national and institutional level (Al-Hattami, 2025). Finally, ed-tech companies could also take decision regarding an inclusive digital infrastructure to reach at the Vision 2030s objectives of equality and empowerment.

AUTHOR DECLARATIONS

CRediT Author Statement / Author contributions

Neha: Conceptualization; Methodology; Software; Validation; Formal Analysis; Investigation; Resources; Data Curation; Writing – Original Draft.
Anil Khurana: Writing – Review & Editing; Visualization; Supervision and Project Administration.

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