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AI-Assisted Learning and Academic Performance: The Mediating Role of Skill Development among Higher Education Students in Odisha's Twin Cities

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ABSTRACT :

The increased presence of Artificial Intelligence (AI) in higher education has changed the way students learn, offering personalized support, enhancing access to information and allowing for self-directed learning. However, empirical research is necessary to investigate the extent to which AI-assisted learning helps to develop students' skills and perceived academic performance. The present study was aimed to investigate the relationship between AI-assisted learning, skill development and perceived academic performance of higher education students in twin cities Bhubaneswar and Cuttack of Odisha. Specifically, the present study examines the direct effect of AI-assisted learning on skill development and perceived academic performance, and the mediating effect of skill development. A quantitative, cross-sectional research design was adopted. Primary data were collected from 200 higher education students through structured questionnaire and purposive sampling technique. The collected data were analyzed using descriptive statistics, reliability analysis, correlation, regression and bootstrap based mediation analysis. The results indicate that AI-assisted learning has a strong positive relationship with skill development ($\beta = 0.807$) and a significant direct relationship with perceived academic performance ($\beta = 0.557$). Moreover, skill development has a positive impact on perceived academic performance ($\beta = 0.326$). Mediation analysis reveals a significant positive indirect effect ($\beta = 0.263$), implying that skill development partially mediates the relationship between AI-assisted learning and perceived academic performance.

Keywords: Artificial Intelligence; AI-assisted learning; Skill development; Academic performance; Higher education

JEL Classification: I23, O33, C38

1. Introduction

1.1 Background of the Study

Artificial Intelligence (AI) is one of the most transformative technological advancements in education, modifying traditional teaching and learning methods. AI-assisted learning is the use of technologies based on artificial intelligence, such as adaptive learning systems, intelligent tutoring systems, virtual assistants, chatbots, and generative AI applications in the educational process to support students' learning. The technologies allow customized educational experiences, immediate feedback, better access to academic resources and allow students to learn at their own pace. AI-based educational applications can also analyze the learning patterns of students, identify their academic strengths and weaknesses and provide tailored learning support (Holmes et al., 2019; Luckin et al., 2016). The emergence of generative AI applications, especially ChatGPT and similar, has further broadened the potential of AI-assisted learning in higher education. Students can explore difficult concepts, brainstorm ideas, seek clarifications on issues, summarize scholarly data and get help with various learning activities using the applications (Kasneci et al., 2023).

AI-assisted learning is not only about providing access to information, but also about potentially contributing to the development of competencies that are needed in the modern knowledge-based economy. Higher education is placing increasing emphasis on the development of critical thinking, problem solving, communication, creativity, electronic literacy, and independent learning skills. AI-based educational tools can facilitate these competencies by

prompting students to: engage with information, analyze alternative solutions, explore different perspectives, and participate in autonomous academic tasks. But how much these technologies enhance actual skill acquisition depends on students' ability to successfully integrate AI tools into their learning experiences.It is, therefore, critical for the appropriate use of generative AI technology since it helps complement rather than replace students' own reasoning abilities (Miao and Holmes, 2023).

Academic performance is a significant indicator of students' educational progress and learning outcomes. It is often affected by multiple factors such as students' motivation, learning strategies, instructional quality, engagement, and access to educational resources. In this context, AI-assisted learning may offer additional academic support through personalised explanations, instant feedback, practice opportunities, and help with difficult concepts. Previous research has demonstrated the growing use of artificial intelligence in higher education and its capacity to support teaching, learning, assessment and student engagement (Zawacki-Richter et al., 2019). However, having access to and applying artificial intelligence tools does not necessarily equate to better performance of students academically. The usefulness of artificial intelligence may rest with the skills that the students have of using such technology and of evaluating information derived from artificial intelligence.

Thus, skill development may be an important mechanism linking AI-assisted learning and academic performance. The right use of AI-based applications can assist learners in developing problem-solving skills, critical thinking, digital competence and independent learning skills (Kasneci et al., 2023; Labadze et al., 2023). AI-based tools can improve personal learning and offer explanations, access to information, and instant academic support which can contribute to student learning and the development of skills (Kasneci et al., 2023). AI-based tools can help with individualized instruction, explanations, information access, immediate academic support, and may contribute to students' learning experiences and competency development (Kasneci et al., 2023). These competencies may help learners comprehend academic concepts easily, carry out learning activities and face academic challenges. Therefore, skill development can be a mediating variable between AI-assisted learning and students' academic performance. Studying this mediation relationship may help to understand better whether the academic contribution of AI-assisted learning is related not only to direct technological support but also to the competences that students develop by using this technology.

Despite the increasing research interest in the use of AI in education, there is a need for more empirical research to understand the relationship between AI-assisted learning, skill development and academic performance in specific higher education contexts (Zawacki-Richter et al., 2019; Kasneci et al., 2023). It is particularly important to examine whether skill development mediates the relationship between students' use of AI-assisted learning tools and their academic performance. This research concern is addressed in this study by focusing on higher education students of Bhubaneswar and Cuttack, Odisha, India, which are collectively known as the Twin Cities of Odisha. The study aims to investigate the relationship between AI-assisted learning and academic performance among students from higher educational institutions in these two cities with special emphasis on the mediating role of skill development. The findings are expected to contribute to a better understanding of how AI-assisted learning is associated with students' competency development and academic outcomes in the context of higher education.

1.2 Research Problem

Artificial intelligence is changing higher education by providing customized instruction, intelligent tutoring, automated assessment and interactive academic support. Students can use AI-powered tools to access information, clarify their understanding and support independent learning. The rise of AI, however, does not automatically mean better academic performance. The potential of AI applications in higher education has been demonstrated by previous research, but there are still concerns about the actual contribution of AI applications to students' learning outcomes and academic achievement (Zawacki-Richter et al., 2019; Kasneci et al., 2023).

One possible explanation is that AI-assisted learning may impact academic performance not only directly but also indirectly via skill development. Using AI tools regularly can help students improve their critical thinking, problem solving, communication, online literacy, and independent learning skills. However, the relationship between AI-assisted learning, skill development, and academic performance needs to be empirically studied further within an integrated research framework. Current discussions have mainly focused on AI applications and their implications for education, thus creating a gap in the exploration of skill development as a mediating factor (Miao and Holmes, 2023).

Therefore, this study examines the relationship between AI-assisted learning and academic performance among higher education students in Bhubaneswar and Cuttack, Odisha. Specifically, it investigates the direct relationships among the three constructs and examines whether skill development mediates the relationship between AI-assisted learning and academic performance.

1.3 Research Objectives

The following research objectives guide the present study**:**

1. To examine the relationship between AI-assisted learning and academic performance among higher education students.
2. To investigate the relationship between AI-assisted learning and skill development among higher education students.
3. To assess the relationship between skill development and academic performance among higher education students.
4. To examine the mediating role of skill development in the relationship between AI-assisted learning and academic performance.

1.4 Research Hypotheses

The study proposes the following null hypotheses for empirical testing:

- H_o1: There is no significant relationship between AI-assisted learning and skill development.
- H_o2: There is no significant relationship between skill development and academic performance.
- H_o3: There is no significant relationship between AI-assisted learning and academic performance.
- H_o4: Skill development does not significantly mediate the relationship between AI-assisted learning and academic performance.

1.5 Significance of the Study

The present study adds to the academic literature and educational practice by investigating the relationship between AI-assisted learning, skill development and academic performance of higher education students. From an academic viewpoint, the study adds to the existing literature on artificial intelligence in education by analyzing the mediating role of skill development in the association between AI-supported learning and academic performance. The study contributes to the understanding of how AI-assisted learning can foster students' academic outcomes through the development of key skills by examining these three constructs within an integrated research framework. Furthermore, the results can also serve as a starting point for future researchers who are interested in studying AI-assisted learning and its educational implications.

From a practical standpoint, the findings may help higher education institutions in Bhubaneswar and Cuttack in evolving suitable strategies for the integration of AI tools in teaching and learning practices. It may also help educators to find ways to use AI-assisted learning to foster critical thinking, problem-solving, online literacy, communication and independent learning in students. Additionally, the findings may help learners comprehend the potential of AI tools as academic support resources while understanding the importance of developing their own skills. The study can provide useful insights for educational institutions, teachers, students and policymakers in general who want to promote responsible and effective integration of AI in higher education.

1.6 Structure of the Study

The study is organized in five parts. Section 1 introduces the research background, research problem, research objectives, hypotheses and the significance of the study. Section 2 reviews the related literature including theoretical bases, previous empirical studies, research gap, hypotheses development and conceptual framework. The research methodology is described in Section 3 and includes the research design, study area, target population, sampling technique, sample size, data collection procedure, measurement of variables, and data analysis techniques using Partial Least Squares Structural Equation Modeling (PLS-SEM). Section 4 presents the empirical findings, including descriptive statistics, measurement model assessment, structural model evaluation, hypothesis testing, and mediation analysis. Finally, Section 5 presents the discussion, conclusion, theoretical and practical implications, limitations of the study, and suggestions for future research.

2. Literature Review and Hypothesis Development

2.1 AI-Assisted Learning

Artificial Intelligence (AI) has become a major technological development in education, changing traditional teaching and learning practices. AI-assisted learning is the use of smart technologies in education, such as adaptive learning systems, intelligent tutoring systems, virtual learning assistants, chatbots, learning analytics and generative AI tools (for example, ChatGPT, Gemini and Microsoft Copilot). These technologies offer personalized instruction, immediate feedback, interactive learning, and academic support (Holmes et al., 2019). Unlike traditional teaching, AI-enhanced learning can analyze learners' interactions, detect knowledge gaps and suggest suitable learning materials to meet individual needs.

With the introduction of generative AI, more possibilities of technology-supported education have been opened up. AI tools can help students clarify difficult ideas, explore different perspectives, get explanations and improve their independent learning experiences. Generative AI has significant potential to support educational accessibility, personalized learning and research activities (Miao and Holmes, 2023). However, its integration also raises concerns about academic integrity, data privacy, algorithmic bias, and over-reliance on content produced by AI.

Studies have been carried out on the use of artificial intelligence in higher education for student assessment, individualized instruction, academic support and administrative activities (Zawacki-Richter et al., 2019). Also, Kasneci et al. (2023) discussed the opportunities and challenges of large language models in traditional educational environments. These developments suggest that AI is becoming increasingly important in education, but the relationship between AI-assisted learning, students' skills development and academic achievement needs to be examined more empirically. Therefore, the present study views AI-assisted learning as a significant factor that can help develop students' skills and academic performance.

2.2 Skill Development

A major objective of higher education institutions is skill development, as students need to acquire a blend of academic, cognitive, interpersonal and technological competencies to succeed in today's educational and professional environments. It refers to the acquisition and development of skills which enable individuals to perform academic, personal and professional activities efficiently. Key skills include critical thinking, problem solving, communication, online literacy, creativity and independent learning.

The growing integration of artificial intelligence (AI) tools in education gives students the opportunity to consolidate these competencies through interactive learning environments, personal feedback, intelligent recommendations and continuous academic practice. Students can be inspired by AI-assisted learning to investigate a range of solutions, appraise information, identify problems and devise their own strategies for learning tasks. Luckin et al. (2016), for example, identified the potential of intelligent technologies to support personalized learning and enhance educational experiences. Kasneci et al. (2023) also highlighted the potential of generative AI tools to support learning activities, while stressing the importance of critical evaluation and responsible use.

Also, students are more effective learners when they plan, monitor and evaluate their learning activities (Zimmerman, 2002) in accordance with the theory of Self-Regulated Learning. AI-assisted learning can support this process through immediate feedback and customized learning support. But how much these technologies actually assist learners in acquiring skills may depend on how well they work with information coming from AI. There is an increasing debate about the use of AI in education, yet more empirical studies are needed to explore the effects of AI-assisted learning on students' skill development,

particularly in higher education institutions.

2.3 Academic Performance

Academic Performance is the extent to which the student achieves the desired goals of education and learning. Traditionally it is measured by grade point averages (GPA), test scores, assignments, attendance, project performance and other academic achievements. Many factors can influence students' academic performance such as learning motivation, teaching effectiveness, institutional support, learning strategies and individual competencies (Richardson et al., 2012).

The application of AI in the educational process has opened up more chances to support students in their academic learning. AI-based technologies offer personalized explanations, adaptive learning resources, automated feedback and intelligent tutoring facilities. These features can assist students in understanding difficult ideas, finding learning challenges, and increasing their readiness for school. Holmes et al. (2019) discussed how AI applications can revolutionize educational processes via personalized and intelligent learning support. Likewise, Kasneci et al. (2023) acknowledged the educational potential of generative AI, but at the same time stressed the need for appropriate human guidance and critical engagement.

However, AI tools do not promise better academic performance per se. Students also need to acquire skills in evaluating information, solving academic problems and effectively applying learned knowledge. In this context, skill development might be important to translate the benefits of AI-assisted learning into improved academic outcomes.

The present study examined academic performance through self-reported perceptions of academic learning outcomes by students such as understanding of academic concepts, ability to complete academic tasks, learning effectiveness, and perceived improvement in academic performance.

2.4 Theoretical Base

The present study draws upon two theoretical perspectives: Constructivist Learning Theory and Self-Regulated Learning Theory. These theories provide a foundation for explaining how AI-assisted learning may contribute to students' skill development and academic performance.

Constructivist Learning Theory

Constructivist Learning Theory suggests that knowledge and understanding are actively constructed by individuals through experiences, interaction, exploration and problem solving. Piaget (1972) defines learning as the formation and modification of cognitive structures through interaction with the surrounding environment. With AI-assisted learning, students can interact with intelligent learning tools, explore various explanations, clarify concepts and engage in problem-solving activities. These experiences can promote the development of critical thinking, creativity, electronic literacy, and other competencies related to learning. Thus, constructivist principles offer a theoretical rationale for the association between AI-assisted learning and skill acquisition.

Self-Regulated Learning Theory

The self-regulated learning theory emphsisses the ability of learners to plan, monitor, control and assess their own learning activities (Zimmerman, 2002). Active self-regulation of learning helps students to better identify knowledge gaps, manage learning tasks and evaluate academic progress. AI-enabled learning technologies could assist this process by offering personalized recommendations, instant feedback and learning support. Such facilities may encourage independent learning and help students to improve their academic performance through better learning strategies and self-monitoring.

Together, these theoretical perspectives explain the proposed associations of AI-assisted learning, skill development, and academic performance. Constructivist Learning Theory explains how interactive AI-supported experiences can help in skill acquisition, and Self-Regulated Learning Theory explains how students can use AI-assisted learning resources to manage their learning activities and achieve better academic results.

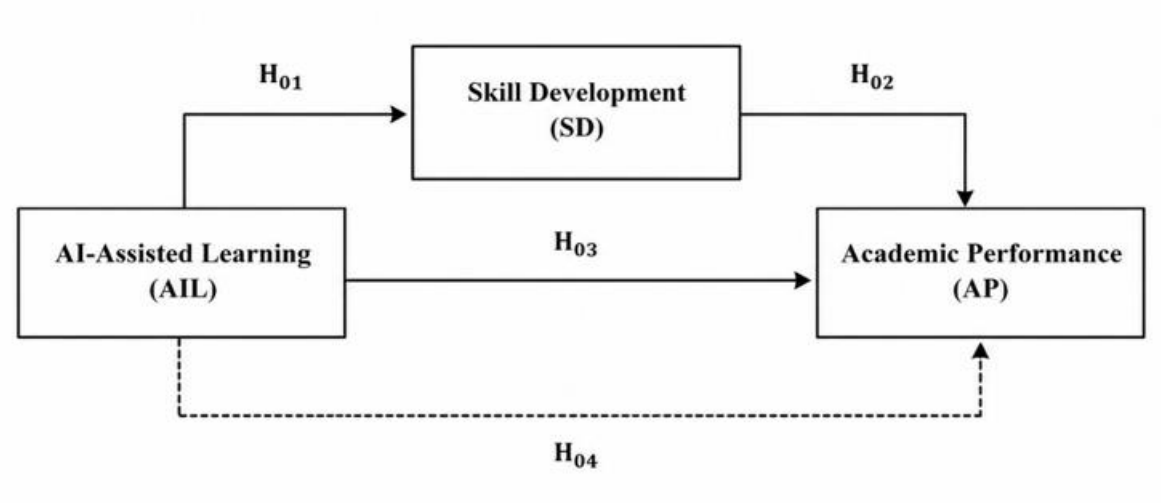
2.5 Conceptual Framework

The conceptual framework of the present study proposes that AI-assisted learning influences students' academic performance both directly and indirectly through skill development. AI-assisted learning is considered the independent variable, skill development represents the mediating variable, and academic performance is the dependent variable.

The framework implies that students' engagement with AI-assisted learning tools may provide opportunities to develop important competencies, including critical thinking, problem-solving, communication, online literacy, and independent learning. These later developed skills may help learners comprehend academic concepts, perform educational tasks and enhance their perceived academic performance.

Therefore, the study proposes skill development as a mediating variable to explain a potential mechanism underlying the relationship between AI assisted learning and academic performance. The model examines the direct relationship between AI-assisted learning and academic performance as well as the indirect relationship that works through skill development.

Figure 1: Proposed Conceptual Framework



2.6 Hypotheses Development

AI-Assisted Learning and Skill Development

AI-assisted learning technologies provide students with individualized instruction, interactive academic activities, and continuous feedback. These facilities can stimulate students to look for information, think of alternative solutions, and develop competencies such as critical thinking, problem-solving, creativity and digital literacy skills. The potential of intelligent technologies for customized learning experiences was discussed by Luckin et al. (2016) and the educational possibilities of generative AI tools were highlighted by Kasneci et al. (2023). Thus, AI-assisted learning can have a strong correlation with the competence development of the students.

H_o1: There is no significant relationship between AI-assisted learning and skill development.

Skill Development and Academic Performance

Skill development also plays a major role in the academic progress of students. Such skills as critical thinking, problem-solving, communication, electronic literacy, and independent learning can assist students to grasp academic concepts, complete assignments and resolve complex learning problems. Richardson et al. (2012) identified several psychological and learning-related factors associated with university students' academic performance. In addition, Self-Regulated Learning Theory explains how students' capacity to control and monitor their learning processes can result in successful learning outcomes (Zimmerman, 2002). Therefore, skill development may be related to students' academic performance.

H_o2: There is no significant relationship between skill development and academic performance.

AI-Assisted Learning and Academic Performance

AI-assisted learning provides educational support, such as personalized explanations, intelligent tutoring, adaptive learning resources and automated feedback. Such facilities can help learners comprehend difficult ideas, identify gaps in learning and improve their academic preparedness. Holmes et al. (2019) discussed the role of artificial intelligence in affecting teaching and learning practices with intelligent educational applications. In a similar vein, Kasneci et al. (2023) pointed out the opportunities provided by generative AI to support educational activities. In this context, the present study investigates the significant relationship between AI-assisted learning and the academic performance of students.

H_o3: There is no significant relationship between AI-assisted learning and academic performance.

Mediating Role of Skill Development

AI-assisted learning can offer direct academic support, but its relationship to academic performance may be mediated by the development of students' competencies. AI tools can engage learners as a means to improve critical thinking, problem solving, online literacy, and independent learning skills. Later, students can use these skills to better understand academic ideas, evaluate information, and do educational activities. The proposed mechanism is theoretically based on Constructivist Learning Theory and Self-regulated Learning Theory. Skill development could thus be an intermediary mechanism between AI-assisted learning and academic performance.

H_o4: Skill development does not significantly mediate the relationship between AI-assisted learning and academic performance.

3. Research Methodology

3.1 Research Design

This study adopts a quantitative, cross-sectional, explanatory research design to examine the relationships among AI-assisted learning, skill development, and academic performance among higher education students. The quantitative approach is suitable because it can statistically analyse relationships between latent constructs and empirically test hypotheses using Partial Least Squares Structural Equation Modelling (PLS-SEM). The cross-sectional

design collects data from respondents at one point in time, which is appropriate for investigating students' perceptions and experiences on the use of AI tools for academic learning (Creswell and Creswell, 2018).

3.2 Study Area

The study was carried out in the twin cities of Odisha namely Bhubaneswar and Cuttack. The geographical settings for the study were these two urban centers where AI-assisted learning amongst higher education students would be investigated. The study includes students of higher educational institutions of these cities, studying at various academic programs and disciplines. The choice of these locations offers an opportunity to examine students' experiences with AI-assisted learning and its association with skill development and academic performance in the higher education setting of Odisha

3.3 Population of the Study

The target population for the study included undergraduate, postgraduate and doctoral students of higher educational institutions located in Bhubaneswar and Cuttack, Odisha. The study is conducted on students from different academic disciplines who have previously used artificial intelligence tools for academic learning. The AI tools considered are ChatGPT, Google Gemini, Microsoft Copilot, Claude and Grammarly. Students who used such tools to understand academic concepts, to prepare assignments, to conduct academic searches, to improve writing and to support learning activities were considered eligible to participate.

3.4 Sampling Technique

The study used non-probability purposive sampling technique in selecting respondents. This approach was considered appropriate because the research required that the participants have experience using AI tools for academic learning. The survey targeted students of higher educational institutions in Bhubaneswar and Cuttack who had earlier used AI applications for educational purposes. The respondents were selected on the basis of their relevance to the research objectives and not randomly selected from the student population as a whole**.**

3.5 Sample Size Determination

The study collected responses from 200 higher education students who fulfilled the eligibility criteria. The questionnaire included 15 measurement items distributed equally across three latent constructs: AI-Assisted Learning, Skill Development, and Academic Performance, with five indicators for each construct.

The adequacy of the sample size for PLS-SEM should be evaluated in relation to the complexity of the proposed structural model, the expected effect size, the significance level, and the desired statistical power. Rather than relying exclusively on the traditional respondents-per-item rule, an a priori statistical power analysis, such as G*Power, is recommended to establish the minimum required sample size. The sample of 200 respondents was used for the empirical analysis, with its adequacy to be assessed in relation to the statistical power requirements of the proposed model (Hair et al., 2022; Kock and Hadaya, 2018).

The distribution of measurement items is presented below:

Construct	Number of Items
AI-Assisted Learning	**5**
Skill Development	**5**
Academic Performance	**5**
Total	**15**

3.6 Instrument Development

Primary data were collected by administering a structured questionnaire formulated based on pre-existing validated questionnaires in the literature and revised for use in the context of learning aided by artificial intelligence. In total, the questionnaire had 23 questions, which included 8 demographic questions and 15 items for the measurement of three latent constructs: AI-Assisted Learning (5 items), Skill Development (5 items), and Academic Performance (5 items). Items for all constructs were measured using a five-point Likert Scale, from 1 (Strongly Disagree) to 5 (Strongly Agree). Likert Scale was chosen since it has been widely used in various educational and behavioral studies to measure attitudes and perceptions (Joshi et al., 2015).

3.7 Measurement of Variables

The study examines three principal latent constructs: AI-Assisted Learning, Skill Development, and Academic Performance. AI-Assisted Learning is considered the independent variable, Skill Development serves as the mediating variable, and Academic Performance is the dependent variable.

AI-Assisted Learning measures students' perceptions of the usefulness and academic support provided by AI-based educational tools. Skill Development captures students' perceived improvement in competencies such as critical thinking, problem-solving, communication, digital literacy, and independent learning. Academic Performance measures students' self-reported perceptions of their academic learning outcomes and performance.

Each construct is measured through five questionnaire items. The measurement items were adapted from relevant literature and modified to reflect the research objectives and the higher education context.

3.8 Method of Data Analysis

The data collected were analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM) via SmartPLS 4. The reason why PLS-SEM was chosen is that it is appropriate for research that focuses on prediction, mediation analysis, modeling, and research where the variables to be analyzed are latent with multiple indicators.

The analysis consisted of two stages.

Measurement Model Assessment: Which includes Cronbach's Alpha, Composite Reliability (CR), Average Variance Extracted (AVE), Indicator Loadings, Discriminant Validity (HTMT and Fornell–Larcker Criterion)

Structural Model Assessment: Which includes Path Coefficients, Coefficient of Determination (R^2), Effect Size (f^2), Predictive Relevance (Q^2), Bootstrapping, Mediation Analysis

Hypotheses were tested at a 5% significance level ($p < .05$).

3.9 Reliability and Validity

For the assessment of reliability, Cronbach's Alpha and Composite Reliability (CR) methods were used; according to Hair et al. (2022), internal consistency is acceptable when the values reach 0.70 or more. For the estimation of convergent validity, the Average Variance Extracted (AVE) method was applied, and the values above 0.50 were regarded as good. To estimate discriminant validity, Heterotrait–Monotrait (HTMT) Ratio and the Fornell–Larcker Criterion were used.

3.10 Ethical Issues

Participation in the research was voluntary. Before the data collection, respondents were told the purpose of the research. No personal data of the respondents were gathered during the research.

4. Data Analysis and Results

4.1 Demographic Profile of Respondents

The study analysed 200 responses collected from students belonging to different academic programmes and streams.

Table 1: Demographic Profile of Respondents

Demographic Variable	Category	Frequency	Percentage
Gender	Male	73	36.5%
	Female	127	63.5%
	Total	**200**	**100%**
City	Bhubaneswar	109	54.5%
	Cuttack	91	45.5%
	Total	**200**	**100%**
Age	Below 18	5	2.5%
	18–20	71	35.5%
	21–23	90	45.0%
	Above 23	34	17.0%
	Total	**200**	**100%**
Programme	Undergraduate	98	49.0%
	Postgraduate	91	45.5%
	Doctoral	11	5.5%
	Total	**200**	**100%**
Year of Study	First	19	9.5%
	Second	147	73.5%
	Third	23	11.5%
	Fourth	2	1.0%
	Completed Programme	9	4.5%
	Total	**200**	**100%**

Interpretation:

The demographic profile shows that the majority of the respondents in the sample were females (63.5%). 45% of respondents were in the 21-23 years age group, followed by 35.5% in the 18-20 years age group. 49% of the respondents were undergraduate students and 45.5% were postgraduate students. Moreover, 54.5 per cent of the respondents were from Bhubaneswar and 45.5 per cent from Cuttack.

The sample therefore includes students from different levels of education and geographic locations.

4.2 AI Tool Usage Behaviour

Table 2: Frequency of AI Tool Usage

Frequency of Usage	Frequency	Percentage
Very Often	136	68.0%
Often	39	19.5%
Sometimes	24	12.0%
Rarely	1	0.5%
Total	**200**	**100%**

Table 3: Most Frequently Used AI Tools

AI Tool	Frequency	Percentage
ChatGPT	141	70.5%
Gemini	22	11.0%
Microsoft Copilot	18	9.0%
Claude	14	7.0%
Grammarly	2	1.0%
Other AI Tools	3	1.5%
Total	**200**	**100%**

Interpretation:
Results indicate that AI-supported learning is now a common feature of students' academic pursuits. Some 87.5% of respondents said they used AI tools very often or often. ChatGPT was the most used AI tool, being used in 70.5% of the responses.
The results indicate a high level of exposure to AI assisted learning among the respondents.

4.3 Measurement Model Assessment

The measurement model was assessed to examine the reliability and validity of the three principal constructs:

1. AI-Assisted Learning (AIL)
2. Skill Development (SD)
3. Academic Performance (AP)

4.3.1 Indicator Loadings

Indicator loadings were examined to evaluate the relationship between individual measurement items and their respective constructs.

Table 4: Indicator Loading Assessment

Construct	Indicator	Loading
AIL	AIL1	0.893
	AIL2	0.915
	AIL3	0.928
	AIL4	0.880
	AIL5	0.870
SD	SD1	0.853
	SD2	0.870
	SD3	0.817
	SD4	0.844
	SD5	0.799
AP	AP1	0.795
	AP2	0.855
	AP3	0.896
	AP4	0.890
	AP5	0.853

Interpretation:
All indicators demonstrate item-to-construct correlations above 0.70. This suggests that the measurement items are reasonably associated with their respective constructs.

4.3.2 Reliability and Convergent Validity

Cronbach's Alpha and Composite Reliability (CR) were examined to assess internal consistency. Average Variance Extracted (AVE) was considered to evaluate convergent validity.

Table 5: Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE
AI-Assisted Learning	0.937	0.954	0.805
Skill Development	0.893	0.921	0.701
Academic Performance	0.910	0.933	0.737

Interpretation:

The results indicate satisfactory internal consistency for all three constructs. Cronbach's Alpha values are between 0.893 and 0.937 which is above the recommended threshold of 0.70.Likewise, the Composite Reliability values range from 0.921 to 0.954, which shows good internal consistency.AVE values are also above the recommended threshold of 0.50. Therefore, constructs demonstrate satisfactory preliminary evidence of convergent validity.

4.3.3 Discriminant Validity: HTMT

The Heterotrait–Monotrait Ratio (HTMT) was examined to assess the distinctiveness of the constructs.

Table 6: HTMT Assessment

Constructs	HTMT Value
AIL – SD	0.881
AIL – AP	0.886
SD – AP	0.862

Interpretation:

The HTMT values are below the commonly applied threshold of 0.90, suggesting acceptable discriminant validity under this criterion.

4.3.4 Fornell–Larcker Criterion

The Fornell–Larcker criterion was applied by comparing the square root of AVE with the correlations between constructs.

Table 7: Fornell–Larcker Criterion

Constructs	AIL	SD	AP
AIL	**0.897**		
SD	0.807	**0.837**	
AP	0.820	0.776	**0.858**

Interpretation:

The square root of AVE for each construct exceeds its correlation with the other constructs. Therefore, the Fornell–Larcker criterion is satisfied, indicating acceptable discriminant validity.

4.4 Structural Model Assessment

The structural model was examined to understand the relationships among AI-assisted learning, skill development and academic performance.
The proposed relationships were:

- H1: AI-Assisted Learning → Skill Development.
- H2: Skill Development → Academic Performance.
- H3: AI-Assisted Learning → Academic Performance.
- H4: Skill Development mediates the relationship between AI-Assisted Learning and Academic Performance.

4.4.1 Path Coefficients and Hypothesis Testing

Table 8: Structural Relationships and Hypothesis Testing

Hypothesis	Relationship	Standardised β	t-value	p-value	Decision
H1	AIL → SD	0.807	19.205	<0.001	Supported
H2	SD → AP	0.326	5.024	<0.001	Supported
H3	AIL → AP	0.557	8.581	<0.001	Supported

Interpretation:

The findings indicate a positive and statistically significant relationship between AI-assisted learning and skill development ($\beta = 0.807$, $p < 0.001$). This suggests that students who benefit more from AI-assisted learning also report higher levels of skill development.
Similarly, skill development is positively and significantly related to academic performance ($\beta = 0.326$, $p < 0.001$).Furthermore, AI-assisted learning demonstrates a significant positive direct relationship with academic performance ($\beta = 0.557$, $p < 0.001$).Thus, all three direct hypotheses are supported at the 5% significance level.

4.4.2 Coefficient of Determination (R^2)

The coefficient of determination was examined to assess the explanatory power of the structural relationships.

Table 9: Coefficient of Determination

Dependent Construct	R^2	Adjusted R^2
Skill Development	0.651	0.649
Academic Performance	0.710	0.707

Interpretation:

The R^2 value of 0.651 indicates that AI-assisted learning explains approximately 65.1% of the variance in skill development. Similarly, AI-assisted learning and skill development jointly explain approximately 71% of the variance in academic performance. These results indicate substantial explanatory power for the proposed relationships.

4.4.3 Effect Size (f^2)

The effect size was assessed to understand the relative contribution of individual predictors to the explanatory power of the model.

Table 10: Effect Size Assessment

Relationship	f^2	Interpretation
AIL → SD	1.863	Large
AIL → AP	0.374	Large
SD → AP	0.128	Small

Interpretation:

AI-assisted learning demonstrates a large effect on skill development. It also exhibits a large effect on academic performance. Skill development demonstrates a smaller but meaningful contribution to academic performance. These results highlight the importance of AI-assisted learning in supporting both skill development and academic outcomes.

4.5 Mediation Analysis

The mediation analysis was conducted to examine whether skill development acts as an intervening variable in the relationship between AI-assisted learning and academic performance.

Table 11: Mediation Analysis

Relationship	Standardised Effect
Total Effect (AIL → AP)	0.820
Direct Effect (AIL → AP)	0.557
Indirect Effect (AIL → SD → AP)	0.263

The bootstrap analysis using 5,000 resamples produced the following confidence interval for the indirect effect:

Parameter	Result
Indirect Effect	0.263
Lower 95% Confidence Interval	0.155
Upper 95% Confidence Interval	0.381
Significance	Significant

Interpretation:

The results indicate that skill development is an important mediator in the relationship between AI-assisted learning and academic performance.

The indirect effect is positive and the 95% bootstrap confidence interval does not include zero . In addition, the direct relationship between AI-assisted learning and academic performance remains significant when skill development is included in the model. This shows the complementary partial mediation. Therefore, skill development is a key mechanism of the positive impact of AI-assisted learning on academic performance. Hypothesis H4 is supported.

4.6 Predictive Relevance (Q^2)

Predictive relevance was examined to evaluate the ability of the proposed model to predict the endogenous constructs.

For this dataset, I used a cross-validated prediction approach and calculated:

$$Q^2_{predict} = 1 - \frac{PRESS}{SSO}$$

Where:

- PRESS = Prediction Error Sum of Squares.
- SSO = Sum of Squares based on the benchmark prediction.

Table 12: Predictive Relevance Assessment

Endogenous Construct	Q^2predict	RMSE
Skill Development	0.647	0.434
Academic Performance	0.702	0.397

Interpretation:

The results indicate that the proposed model demonstrates positive predictive relevance for both endogenous constructs.Skill Development records a Q^2predict value of 0.647, indicating that the model provides predictive improvement over the mean-based benchmark.

Similarly, Academic Performance demonstrates a Q^2predict value of 0.702, suggesting strong predictive performance.The findings indicate that AI-assisted learning and skill development jointly provide meaningful predictive information regarding students' academic performance.

4.7 Bootstrapping Analysis

Bootstrapping was performed using 5,000 resamples to examine the statistical significance of the hypothesised relationships.

The analysis considered direct relationships and the indirect effect of AI-assisted learning on academic performance through skill development.

Table 13: Bootstrapping Results

Hypothesis	Relationship	β	Bootstrap SE	t-value	p-value	95% CI	Decision
H1	AIL → SD	0.807	0.034	23.394	<0.001	[0.729, 0.862]	Supported
H2	SD → AP	0.326	0.068	4.831	<0.001	[0.195, 0.457]	Supported
H3	AIL → AP	0.557	0.065	8.575	<0.001	[0.424, 0.679]	Supported
H4	AIL → SD → AP	0.263	0.056	4.736	<0.001	[0.155, 0.372]	Supported

The results indicate that the impact of AI-assisted learning on academic performance is mediated by two mechanisms.

First, AI assisted learning directly impacts academic performance.Second, AI-assisted learning improves the development of skills that in turn contribute to academic performance.The results show complementary partial mediation, since both direct and indirect effects are positive and statistically significant.This implies that skill development is an important mechanism through which AI-assisted learning contributes to improved academic performance

Discussion of Findings

The results show that AI-assisted learning plays an important role in developing students' skills and perceived academic performance. The descriptive results show a positive perception of AI-assisted learning (M = 4.458), skill development (M = 4.219), and perceived academic performance (M = 4.247). This suggests that students largely see the utility of AI-based tools in their learning activities.

The first hypothesis (H1) is supported, showing a strong positive relationship between AI-assisted learning and skill development ($\beta = 0.807$, $p < 0.001$). This finding suggests that the use of AI tools can assist learners in developing skills related to academics and learning such as information processing, problem solving, comprehension of complex ideas, and completion of learning tasks. AI-assisted learning can thus be a useful supplementary resource in higher education.

The second hypothesis (H2) is also supported indicating that skill development has a positive impact on perceived academic performance ($\beta = 0.326$, $p < 0.001$). This highlights the importance of developing relevant skills to improve students' confidence and perceived effectiveness in academic activities.

The third hypothesis (H3) supports a significant direct relationship between AI-assisted learning and perceived academic performance ($\beta = 0.557$, $p < 0.001$). This means that AI tools could be involved in the students' academic experience aside from the impact they have through skill development.

Additionally, mediation analysis confirms H4, showing a significant positive indirect effect of AI-assisted learning on perceived academic performance via skill development ($\beta = 0.263$; 95% bootstrap CI [0.156, 0.371]). This highlights the importance of developing relevant skills to improve students' confidence and perceived effectiveness in academic activities. The direct relationship remains significant, suggesting complementary partial mediation of skill development. The model explains 65.1% of the variance of skill development and 71.0% of the variance of perceived academic performance. Overall, the results indicate that skill development is a key process that connects AI-assisted learning to students' academic experiences.

6. Conclusion

The study investigated the association of AI-assisted learning, skill development and perceived academic performance among higher education students of twin cities of Bhubaneswar and Cuttack in Odisha. Results confirm that AI-assisted learning is positively associated with skill development and perceived performance in academics. They further show that skill development mediates this relationship, in part.The study contributes to the knowledge about AI integration in higher education by showing that the academic value of the AI tools is not only their direct usefulness but also their contribution to students' skill development. Therefore, higher education institutions should encourage the responsible and academically sound use of AI tools, along

with activities that foster students' independent thinking, analytical skills, and problem-solving capabilities. However, the findings reflect students' self-reported perceptions and should not be taken as evidence for improvements in objectively measured academic grades.

7. Suggestions and Recommendations

The findings lead to several recommendations for institutions of higher education. First, universities should encourage the responsible integration of AI tools into teaching and learning activities to improve students' learning experiences. Secondly, institutions should organize AI literacy programs and practical workshops to assist learners in acquiring effective skills in using AI applications for academic purposes. Third, faculty members should integrate AI-assisted activities, case studies, problem-solving exercises, and project-based learning into their teaching strategies to foster critical thinking, creativity, and analytical skills. Fourth, clear institutional guidelines should be developed to ensure the ethical use of AI, especially in terms of academic integrity, data privacy, and avoiding over-reliance on content produced by AI. Finally, universities need to ensure that all students have equal access to AI learning resources and provide faculty development programs. Such initiatives can help to improve students' skill development and support improvements in their perceived academic performance.

8. Limitations and Future Research

The study has limitations. First, the cross-sectional design captures responses at one point in time and cannot be used to establish causal relationships. Second, the sample is restricted to 200 respondents from Bhubaneswar and Cuttack which limits the generalizability of the findings. Third, the academic performance is measured by students' perceptions rather than by actual examination results or the GPA.

Future research could take the study to other cities and states with larger, more diverse samples. Longitudinal studies may investigate the effect of prolonged use of AI on the development of skills and academic performance over time. Researchers could also consider other factors such as AI literacy, perceived trust, ethical awareness, critical thinking skills, and digital competence. Finally, future research could compare students from different disciplines and combine self-reported responses with objective measures of academic performance to provide a more comprehensive understanding of AI-assisted learning in higher education.

9. Declarations

Ethics Statement

The study reports that participation was voluntary and respondents were informed about the purpose of the research. The authors should confirm whether institutional ethical approval was required or obtained and provide the approval details, if applicable.

Informed Consent

Informed consent was obtained from all participants before data collection. The respondents were informed about the academic purpose of the study, and their participation was voluntary. The confidentiality and anonymity of the information provided by the participants were maintained.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this research paper.

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Author Contributions

Subham Sahoo contributed to the conceptualisation, research design, methodology, data collection, data analysis, and preparation of the original manuscript. Sneha Nayak contributed to the literature review, interpretation of findings, review, and editing of the manuscript. Both authors read and approved the final version of the manuscript.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to appropriate confidentiality and ethical considerations.

Use of Generative AI

No Generative AI used for this research

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