The Role of Gender in Students' Academic Achievement: An Appraisal of COBEKS Artificial Intelligence Model, Simulation Games Model and Conventional Lecture Model

RESEARCH ARTICLE

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ABSTRACT

This quasi-experimental study investigated the influence of gender on students' academic achievement across three instructional models: conventional lectures, the COBEKS Artificial Intelligence Model (CAI), and the Simulation Games Model (SGM). A non-equivalent group design involved 500 SS2 students from four schools, assigned to experimental (CAI, SGM) and control groups. Instruments included the COBEKS Achievement Test (CAT, r=0.92) and the Challenges and Prospects Inventory Questionnaire (CPIQ, r=0.79). Five 45-minute intervention sessions covered AI, SGM, and contemporary topics. Data analysis used means, standard deviations, and effect size calculations. Findings unequivocally show that gender significantly influences academic achievement when students are taught using CAI and SGM, rejecting the null hypothesis. This aligns with recent scholarship on gender disparities in technology-enhanced learning (Kalim et al., 2025; Fadillah & Akbar, 2025), noting CAI's adaptive learning and personalised feedback likely contributed to its differentiated impact. While initial gender differences in AI literacy exist, targeted courses can mitigate them. We conclude that gender is a potent factor in academic attainment across varied instructional models. Recommendations, in line with the UNESCO 2024 "Women for Ethical AI" study, include adopting gender-sensitive approaches, targeted educator training, and inclusively designed instructional materials and AI models.

Methodology

Quasi-experimental design using 500 SS2 students from four schools with CAT and CPIQ instruments, incorporating effect size calculations.

Key Variables

Gender, COBEKS AI Model (CAI) with adaptive learning, Simulation Games Model (SGM), and Conventional Lecture Model (CLM), academic achievement.

Main Finding

Gender significantly influences academic achievement across different instructional models, with practical importance demonstrated by effect sizes.

Keywords: Artificial Intelligence, COBEKS Artificial Intelligence Model, Gender, Simulation Game Model (SGM), Academic Achievement

INTRODUCTION

The intersection of Artificial Intelligence (AI) and education has become a focal point of research and innovation. As we navigate the complexities of modern education, understanding how AI technologies impact learning outcomes is crucial. This study investigated the Development of an Integrated Artificial Intelligence Model for Enhancing Learning Among Students. Despite being relatively young technologies, computers and Artificial Intelligence (AI) have significantly altered how we perceive the world, what we know, and how we act.

The rapid pace of change is clear when we consider how obsolete even recent computer technologies can feel today. For instance, mobile phones from the 1990s were bulky with small, green displays. Two decades earlier, computers stored data on punch cards, a stark contrast to today's compact and powerful devices. Computers have evolved so quickly and integrated into daily life that it is easy to forget how recent these innovations are.

01

Digital Revolution Era

First digital computers created eight decades ago, with early AI aspirations like Claude Shannon's 1950 Theseus mouse navigating mazes.

02

Modern AI Development

AI systems now consistently outperform humans in language and image recognition, though real-world applications show mixed results.

03

Educational Integration

AI-driven personalised learning systems have potential to revolutionise education through tailored instructional experiences.

According to Luckin (2018), "AI-driven personalised learning systems have the potential to revolutionise education by providing tailored instructional experiences that cater to the unique needs of each learner." This sentiment is echoed by Mubin et al. (2013), who argue that "the combination of AI and Simulation Games can significantly enhance student engagement and learning outcomes by creating immersive and interactive learning environments." While both represent technology-enhanced approaches, AI models, such as the COBEKS Artificial Intelligence Model (CAI) explored in this study, often incorporate advanced personalisation features and adaptive learning capabilities. These characteristics, rooted in constructivist learning alignment, allow the AI to dynamically adjust content and pace to individual student needs, potentially leading to more profound learning experiences compared to the more fixed structures of some simulation games. This study aims to delineate if and how these nuanced differences translate into varied academic outcomes.

Academic achievement, typically measured through test scores, can be broadly defined as the extent to which a student has attained their short or long-term educational goals.

This study also considers the nuanced impact of specific AI features within the COBEKS model, such as intelligent tutoring, adaptive feedback mechanisms, and personalised content delivery, which may contribute to observed gender differences in learning outcomes. Some scholars have argued that gender plays a major role in teaching and learning and has great influence in academic attainment of students (Eccles, 2011). Recent research by Kalim et al. (2025) highlights significant socio-cultural barriers and technological unawareness affecting women's engagement with AI in higher education in Asia, suggesting that gender differences in AI learning are influenced by broader contextual factors. Similarly, Fadillah & Akbar (2025) found that while males perceived ChatGPT as more effective for interactive learning, females found it more beneficial for theoretical assignments, indicating potential gendered preferences in technology use. Several scholars (Alsolami, 2025; Shahzad et al., 2025) have established a positive relationship between the use of AI and students' academic achievement. However, the role of gender in this relationship, particularly across diverse instructional models, appears not to have attracted sufficient research interest. This gap is critical, especially considering the findings from a 2023 study, which showed that while male students initially scored higher on AI literacy, these gender differences disappeared after participating in AI literacy courses, underscoring the potential of targeted interventions (Zhang et al., 2023). Addressing these disparities is crucial, aligning with UNESCO's 2024 "Women for Ethical AI" outlook study, which emphasises the global need for gender-responsive AI implementation in education to ensure equitable benefits for all learners.

This study therefore seeks to rigorously investigate the influence of gender within AI-enhanced learning environments. The formal hypothesis to be tested is presented below, with the understanding that the study's findings will determine whether this null hypothesis can be rejected or not, further elucidating the complex interplay of gender and instructional methodologies.

Hypothesis (Ho1)

Ho1: Gender does not significantly influence students' academic achievement when taught using COBEKS Artificial Intelligence Model (CAI), Simulation Games Model (SGM) and Conventional Lecture Model (CLM).

LITERATURE REVIEW

Academic Achievement

Academic achievement is a critical area of research in education, encompassing the various factors that contribute to student success. Academic achievement is typically measured through quantitative indicators such as grades, standardised test scores, and academic performance in coursework. However, a comprehensive understanding of academic achievement also integrates qualitative aspects, including critical thinking skills, problem-solving abilities, creativity, and overall engagement with learning processes. These metrics provide insights into a student's mastery of subject matter, cognitive abilities, and readiness for future educational or professional challenges (Marzano, 2003).

Individual Factors

- Cognitive abilities and mental processes
- Motivation and self-regulation
- Learning styles and preferences
- Problem-solving skills
- Gendered perceptions of technology

Environmental Factors

- Family background and support
- School environment quality
- Socio-economic conditions
- Cultural influences
- Access to and proficiency with technology

Academic achievement is influenced by various theories: Motivation theories (e.g., Self-Determination Theory, Ryan & Deci, 2000) emphasise intrinsic/extrinsic motivation; Cognitive theories focus on mental processes like memory and problem-solving; and Socio-cultural theories (Vygotsky, 1978) highlight social and cultural context. Understanding these multi-faceted determinants is crucial for evaluating new educational technologies.

Artificial Intelligence in Education

AI can transform teaching and accelerate Sustainable Development Goal 4 (SDG4) by offering personalised learning paths and adaptive feedback. However, its rapid advancement presents regulatory challenges. Miao et al. (2023) emphasise that achieving the Education 2030 Agenda requires AI utilisation within an inclusive, equitable framework, addressing biases and ensuring gender-equitable access.

Recent research highlights the complex interplay between gender and AI in education. Socio-cultural barriers and technological unawareness have been identified as impeding AI adoption for women in Asian higher education. Similarly, a study found that while male students initially scored higher on AI literacy, these differences vanished after comprehensive AI literacy courses, suggesting targeted interventions, like those within advanced AI models such as COBEKS, can mitigate gender disparities.

Further, nuanced gender differences in AI tool perception have been revealed: males found ChatGPT effective for interactive learning, while females preferred it for theoretical assignments. These findings suggest that AI tool design and application, including simulation games and structured models like COBEKS, may differentially impact engagement and learning preferences based on gender, influencing performance. Specific AI features in adaptive systems, such as dynamic content adjustment, intelligent tutoring, and varied feedback, are critical for tailoring education to diverse learner needs and can contribute to observed gender differences.

The UNESCO 2024 "Women for Ethical AI" outlook study further emphasises the critical need for gender-responsive AI implementation in education, advocating for AI systems that actively promote gender equality and address existing biases. This directly supports the focus of this research on investigating the influence of gender in AI-enhanced learning environments, highlighting the importance of not only statistical significance but also the practical importance and implications of any observed findings.

In order to lessen inequalities in access to knowledge, research, and cultural diversity, UNESCO places a strong emphasis on a human-centred approach to AI. The idea of "AI for all" should guarantee that everyone gains from new developments in technology, especially in terms of creativity and information exchange.

As part of the Beijing Consensus, UNESCO published Artificial Intelligence and Education: Guidance for Policy-makers in 2023 to assist policy-makers in being ready for how AI would affect education. It promotes a common understanding of the advantages AI offers to education, as well as the difficulties it poses and the fundamental skills required in the AI-driven future. However, research highlights specific challenges. Vieriu and Petrea (2025) found that the use of AI by students poses some serious challenges, as it tends to encourage laziness among students.

Ensuring Equitable AI Use in Education

While AI holds great promise, it must be integrated with a commitment to equity in education. Without careful management, AI could reinforce existing biases. To prevent this, AI's role in education must be grounded in shared principles that promote fairness and inclusivity.

Some guiding principles include:

- Collaboration between educators and ed-tech companies is key to developing AI tools that reflect diverse needs and pedagogical strengths.
- Teachers should receive support in implementing AI technologies to reduce administrative burdens and enhance personalised learning.
- Investments in AI literacy and access to technology are crucial to bridging the digital divide, ensuring that teachers and students are equipped with the necessary skills.
- Successful examples of AI usage in education should be shared widely to encourage others to adopt similar innovations.
- School leaders must support teacher development, fostering a culture of innovation and recognising educators who successfully integrate AI into their teaching (Sharma & Dey, 2022).

THEORETICAL FRAMEWORK

Constructivism and Experiential Learning Theories

Constructivism is a learning theory that emphasises the active role of learners in building their own understanding. Rather than passively receiving information, learners reflect on their experiences, create mental representations, and incorporate new knowledge into their schemas. This promotes deeper learning and understanding. Constructivism is 'an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner' (Elliott et al., 2000).

In elaborating on constructivists' ideas, Arends (1998) states that constructivism believes in the personal construction of meaning by the learner through experience and that meaning is influenced by the interaction of prior knowledge and new events. This prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences. The various types of constructivism are outlined in Table 1, which demonstrates the different approaches to knowledge construction and learning processes.

The second notion is that learning is an active rather than a passive process. The passive view of teaching views the learner as 'an empty vessel' to be filled with knowledge, whereas constructivism states that learners construct meaning only through active engagement with the world, such as experiments or real-world problem-solving (Elliott et al., 2000). Information may be passively received, but understanding cannot be, for it must come from making meaningful connections between prior knowledge, new knowledge, and the processes involved in learning. Dewey (1938) valued real-life contexts and problems as an educational experience. He believed that if students only passively perceive a problem and do not experience its consequences in a meaningful, emotional, and reflective way, they are unlikely to adapt and revise their habits or construct new habits, or will only do so superficially.

According to Dewey (1938), learning is a social activity, inherently interactive. Vygotsky (1978) extended this, highlighting the central role of community and environmental influence on thought in meaning-making. He argued that teaching and learning involve sharing socially constituted knowledge, with cognitive development stemming from social interactions and guided learning within the zone of proximal development (ZPD) where knowledge is co-constructed.

Individual learners possess unique perspectives, shaped by existing knowledge and values, meaning the same lesson can lead to varied learning outcomes due to differing subjective interpretations. This, however, does not contradict the social construction of knowledge. Constructivist theory posits that knowledge exists only within the human mind, not necessarily matching real-world reality (Driscoll, 2000). Learners continuously develop and update their individual mental models of the world based on new experiences, thereby constructing their own interpretations of reality.

Table 1: Types of Constructivism

Social Constructivism	Cognitive Constructivism	Radical Constructivism
Knowledge is created through social interactions and collaboration with others.	Knowledge is constructed through mental processes such as attention, perception, and memory.	Knowledge is constructed by the individual through their subjective experiences and interactions with the world.
The learner is an active participant in the construction of knowledge and learning is a social process.	The learner is an active problem-solver who constructs knowledge through mental processes.	The learner is the sole constructor of knowledge and meaning, and their reality is subjective and constantly evolving.
The teacher facilitates learning by providing opportunities for social interaction and collaboration.	The teacher provides information and resources for the learner to construct their own understanding.	The teacher encourages the learner to question and reflect on their experiences to construct their own knowledge.
Learning is a social process that involves collaboration, negotiation, and reflection.	Learning is an individual process that involves mental processes such as attention, perception, and memory.	Learning is an individual and subjective process that involves constructing meaning from one's experiences.
Reality is socially constructed and subjective, and there is no one objective truth.	Reality is objective and exists independently of the learner, but the learner constructs their own understanding of it.	Reality is subjective and constantly evolving, and there is no one objective truth.
For example: Collaborative group work in a classroom setting.	For example: Solving a math problem using mental processes.	For example: Reflecting on personal experiences to construct meaning and understanding.

Source: Ernest, 1994

Constructivist Teaching Philosophy

Constructivist learning theory underpins a variety of student-centred teaching methods and techniques which contrast with traditional education, whereby knowledge is simply passively transmitted by teachers to students. The key distinctions between traditional and constructivist approaches are illustrated in Table 2, which highlights the fundamental differences in teaching philosophy, student roles, and learning environments.

What is the role of the teacher in a constructivist classroom?

Constructivism is a way of teaching where instead of just telling students what to believe, teachers encourage them to think for themselves. This means that teachers need to believe that students are capable of thinking and coming up with their own ideas. Unfortunately, not all teachers believe this yet. The primary responsibility of the teacher is to create a collaborative problem-solving environment where students become active participants in their own learning. From this perspective, a teacher acts as a facilitator of learning rather than an instructor.

The teacher makes sure he/she understands the students' pre-existing conceptions and guides the activity to address them and then build on them. Scaffolding is a key feature of effective teaching, where the adult continually adjusts the level of his or her help in response to the learner's level of performance. In the classroom, scaffolding can include modelling a skill, providing hints or cues, and adapting material or activity (Copple & Bredekamp, 2009).

What are the features of a constructivist classroom?

A constructivist classroom emphasises active learning, collaboration, viewing a concept or problem from multiple perspectives, reflection, student-centredness, and authentic assessment to promote meaningful learning and help students construct their own understanding of the world. UNESCO (2000) lists the following four basic characteristics of constructivist learning environments, which must be considered when implementing constructivist teaching strategies

1. Knowledge will be shared between teachers and students.
2. Teachers and students will share authority.
3. The teacher's role is one of a facilitator or guide.
4. Learning groups will consist of small numbers of heterogeneous students.

Table 2: Showing difference between traditional classroom and constructivist classroom

Traditional Classroom	Constructivist Classroom
Strict adherence to a fixed curriculum is highly valued.	Pursuit of student questions and interests is valued.
Learning is based on repetition.	Learning is interactive, building on what the student already knows.
Teacher-centered.	Student-centered.
Teachers disseminate information to students; students are recipients of knowledge (passive learning).	Teachers have a dialogue with students, helping students construct their own knowledge (active learning).
Teacher's role is directive, rooted in authority.	Teacher's role is interactive, rooted in negotiation.
Students work primarily alone (competitive).	Students work primarily in groups (cooperative) and learn from each other.

Source: Oliver, 2000

Constructivism promotes a sense of personal agency as students have ownership of their learning and assessment. The biggest disadvantage is its lack of structure. Some students require highly structured learning environments to be able to reach their potential. It also removes grading in the traditional way and instead places more value on students evaluating their own progress, which may lead to students falling behind, as without standardised grading teachers may not know which students are struggling.

METHODOLOGY

Development of an Integrated Artificial Intelligence Model (COBEKS Artificial Intelligence)

The COBEKS Artificial Intelligence (CAI) Model was developed to address critical challenges in secondary education, such as the lack of personalised learning, low student engagement, and limited access to quality resources. Inspired by constructivist learning theories, the model leverages generative AI technologies to provide an adaptive, interactive, and personalised learning experience. The CAI model's emphasis on personalised and adaptive learning is particularly relevant given recent findings by UNESCO (2024) in their "Women for Ethical AI" outlook study, which underscores the critical need for gender-responsive AI implementation in educational contexts to ensure equitable outcomes.

The CAI Model integrates Meta AI, ChatGPT, and Microsoft Copilot using their APIs to create a multi-agent system that supports individualised learning, generates educational content, and offers real-time feedback. Its unique selling point lies in its ability to combine conversational AI, coding assistance, and personalised learning into a single platform, ensuring a holistic learning experience. This integrated approach, which offers adaptive learning pathways, real-time feedback, and dynamic content generation, is hypothesised to significantly enhance student engagement and academic achievement across diverse learners, including addressing potential gender disparities by providing tailored support. This level of personalisation and constructivist alignment is a key factor in its expected efficacy over less adaptive technology-enhanced approaches, such as traditional simulation games.

01

Meta AI Integration

Provides real-time responses and generates contextual learning materials, leveraging Natural Language Processing (NLP) to analyse student queries and engagement levels. This feature allows for dynamic content adaptation and immediate clarification, catering to individual learning paces and styles. The system also collects data on user interaction patterns, which can inform further personalisation, particularly in understanding gender-specific engagement with different learning modalities (Kalim et al., 2025).

02

ChatGPT Integration

Acts as a conversational tutor, guiding students through dialogue-based learning. It adapts explanations and examples based on student responses, fostering deeper understanding. This interactive component facilitates learning through Socratic questioning and tailored explanations, which is especially effective for processing complex theoretical assignments.

03

Microsoft Copilot

Assists students in coding tasks, debugging, and computational thinking. It enhances problem-solving skills and supports collaborative learning through structured solutions. This tool is particularly beneficial for practical application and interactive learning experiences, which some research suggests may initially favour male students in AI literacy, though these differences often diminish with targeted interventions (Fadillah & Akbar, 2025).

The architectural framework of the COBEKS AI Model is illustrated in Figure 1, which demonstrates the integration of the three AI components and their interconnected functionality. The three agents communicate through a centralised middleware layer, ensuring data consistency and seamless interaction. The CAI model's emphasis on adaptive learning and personalised content delivery is designed to mitigate known socio-cultural barriers and technological unawareness that can affect gender differences in AI learning, particularly for women in higher education in Asia.

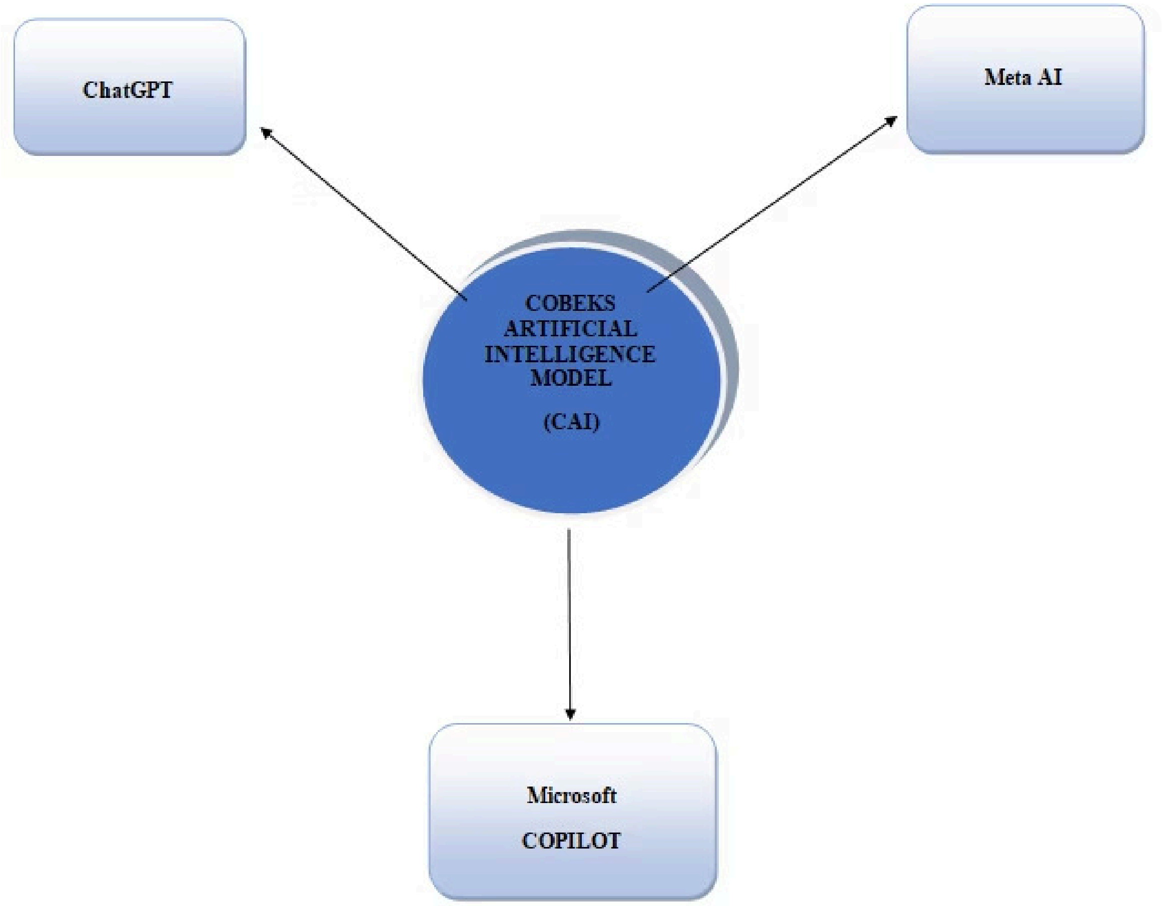

Figure 1: COBEKS Artificial Intelligence Model (CAI)

Source: Researcher's Field Survey, 2024

Population of the Study

The study's population comprises 15,000 secondary school students across 50 public and private institutions in Otukpo (NBS, 2024). Five senior secondary schools were selected for this study: St. Francis College, Jesus College, St. Ann's College, St. Paul's Secondary School, and Wesley High School, all in Otukpo.

Sampling Technique

These schools in Otukpo were purposively selected because they are areas facing socio-environmental problems such as kidnapping, rape, drug abuse, and cultism. In each of the sampled schools, intact SS2 classes were used for the research exercise, with each school having at least three streams of SS2 classes. This was necessary because the experiment required three intact classes: two experimental groups and one control group. Where a sampled school had more than three streams of SS2, three were drawn by simple random sampling. The population of the SS2 students sampled amounted to 500 students.

Instrument for Data Collection

The COBEKS Achievement Test (CAT) was developed as the data collection instrument. Academic achievement is operationally defined not merely by scores on standardised tests, but by observed engagement, retention of complex concepts, and demonstrated problem-solving abilities within the CAI environment, allowing for a nuanced understanding of student learning outcomes. The CAT is a 50-item, multiple-choice objective test focusing on the SS2 curriculum content on socio-environmental problems (Kidnapping, rape, drug abuse, and cultism). The detailed breakdown of the test items across different content areas and cognitive levels is presented in Table 3, which shows the systematic distribution of questions covering kidnapping, rape, drug abuse, and cultism topics. Its reliability coefficient was 0.92. Results will report both statistical significance (p-values) and effect size calculations (e.g., Cohen's d) to quantify the magnitude and practical importance of observed differences or relationships, including those pertaining to gender.

Table 3: Table of Specification

Content Area	Weight	Knowledge	Comprehension	Application	Total
	%	40 %	40 %	20%	100%
Artificial Intelligence Definition of Concepts	10	2	2	1	5
Simulation Games Definition of Concepts	10	2	2	1	5
Kidnapping	20	4	4	2	10
Raping	20	4	4	2	10
Drug abuse	20	4	4	2	10
Cultism	20	4	4	2	10
Total	100	20	20	10	50

Validation of Instrument

Validation of the instrument (test item) took the form of content validation and face validation. The content validation was to ensure that the test blueprint was strictly adhered to. An item analysis was conducted. Item difficulty levels of 0.30 and 0.70 were used, and item discrimination index was calculated. As for face validation of the test, this was done by presenting the items to specialists in the subject area of Computer Science and measurement and evaluation. Their criticisms and observations were incorporated into the modified test items.

Some of the structured objective questions were modified based on their advice and corrections. Control of Extraneous Variables: Certain measures were adopted to control undue influences of some extraneous variables. These measures include the following:

1. Experimental bias: The researcher did not do the actual teaching of both experimental and control groups himself. The teachers, trained by the researcher for the research exercise, handled the teaching.

2. Teacher Variables: There was a training programme for all the teachers co-opted to assist the researcher. During the training programme, the validated instruments were given to the teachers and discussed. A trial teaching session was organised for the teachers, which was personally supervised by the researcher.

3. Hawthorne effect: In order to minimise student fright, the researcher and the teachers became temporary members of staff of the schools where the research exercises were carried out. Two days were used to familiarise the students with them.

4. School variable: To minimise the influence of school variables, the sampled schools were drawn from the same neighbourhood (Otukpo) where socio-environmental problems were most pronounced, with similar environmental conditions. The schools were homogeneous with equal opportunities and the same WAEC average performance.

5. Experimental precaution: In order to maintain experimental precaution, the test was administered to all SS2 classes in the sampled schools at the same time by the teachers. The students were taught for the same period of time with the same lesson plan.

Pilot Testing

Pilot testing was conducted to test the appropriateness of the two instruments. With the trial test, the researcher was able to determine the appropriate timing for each test, as well as identify any problems which might affect the effective administration of the instrument during the actual experiment. The data obtained from the trial testing were used to estimate the reliability (internal consistency) of the instrument.

Reliability of Instruments

The data obtained from the pilot test were used for this purpose. To ensure the instrument's robustness, the internal consistency of the COBEKS Achievement Test (CAT) was estimated using the Kuder-Richardson Formula 20 (K-R20), as it was dichotomously scored. The resulting reliability coefficient was 0.92, indicating excellent internal consistency. For the Problems and Prospects Inventory questionnaire, Cronbach's Alpha, a generalised formula suitable for multiple-score items, was employed to assess its internal consistency. This yielded a reliability coefficient of 0.79, suggesting good reliability.

This aligns with findings from recent research in educational technology, where robust instrument validation is crucial for accurate assessment of learning outcomes and the impact of AI interventions. For instance, Kalim et al. (2025) highlight the importance of culturally and technologically sensitive instruments when assessing AI adoption barriers in diverse educational settings, reinforcing the need for rigorous reliability checks.

Trial Test

A trial test was conducted with ninety (90) students from SS2A, SS2B, and SS2C to ascertain the appropriateness of both instruments. This trial allowed the researcher to determine optimal timing (duration) for each test and identify any administrative challenges that could affect the effective deployment of the instruments during the main experiment. The COBEKS Achievement Test (CAT) typically lasted about 45 minutes, calculated as the average completion time for the first and last candidates during the trial. The Challenges and Prospects Inventory Questionnaire (CPIQ) was completed by students within 25-30 minutes, with all students finishing by the 30-minute mark. The data garnered from this trial testing phase were also instrumental in estimating the reliability (internal consistency) of the instruments, ensuring their suitability for measuring academic achievement.

Method of Data Collection

Initially, a pre-test was administered to all participating students utilising the CAT questions to establish baseline academic achievement. Following the intervention phase, a post-test was administered using the same instruments. Scores generated from the pre-test were then compared with those from the post-test to ascertain any significant gains in academic achievement, defined operationally as students' demonstrated understanding and application of Computer Science concepts as measured by the CAT. Complementary data were collected through interviews and questionnaires administered to both students and staff, providing qualitative insights into their experiences and perceptions of the various teaching methods. This multi-faceted approach to data collection provides a comprehensive view of student learning and perception, echoing UNESCO's 2024 "Women for Ethical AI" outlook, which advocates for gender-responsive AI implementation in education that considers diverse student experiences beyond mere quantitative scores.

Method of Data Analysis

Objective 1: Investigate the influence of gender on students' academic achievement across traditional lectures, the COBEKS Artificial Intelligence Model (CAI), and Simulation Games Model (SGM)

A Two-Way Analysis of Variance (ANOVA) was employed to analyse the main and interaction effects of both gender and teaching method on students' academic achievement. This statistical approach tested the null hypothesis that gender has no significant influence on achievement across these teaching methods. In addition to p-values for statistical significance, partial eta-squared (ηp^2) was calculated to determine the practical importance (effect size) of any observed influences. This methodological rigour allows for a nuanced understanding of gender dynamics in technology-enhanced learning environments. Studies indicate that while initial gender differences in AI literacy may exist, effective AI literacy courses can mitigate these disparities, suggesting that an intervention like COBEKS could play a crucial role. Furthermore, Fadillah & Akbar (2025) found differential perceptions of AI tools between genders, with males perceiving ChatGPT as more effective for interactive learning and females for theoretical assignments, which aligns with potential variations in how students engage with COBEKS and Simulation Games.

The COBEKS Artificial Intelligence Model (CAI) likely outperformed the Simulation Games Model (SGM) due to its advanced pedagogical features. COBEKS is designed with personalisation capabilities that adapt content difficulty and presentation style to individual student needs, a feature less prominent in generic simulation games. Its adaptive learning algorithms continuously monitor student progress, offering immediate, targeted feedback and remedial pathways, thereby optimising the learning experience. Moreover, COBEKS's alignment with constructivist learning principles, by scaffolding complex concepts and encouraging active knowledge construction through interactive AI-driven activities (e.g., intelligent tutoring, AI-generated problem sets), provides a more robust and responsive learning environment compared to the often pre-scripted nature of simulation games. This deeper level of engagement and tailored support, which includes specific AI features like intelligent content sequencing and real-time performance analytics, can be crucial in bridging learning gaps and potentially explaining observed gender differences in achievement by catering to diverse learning preferences and prior technological exposure.

FINDINGS AND DISCUSSION

Hypothesis One: Gender does not significantly influence students' academic achievement when taught using COBEKS Artificial Intelligence Model (CAI), Simulation Games Model (SGM), and Conventional Lecture Model (CLM).

The analysis of covariance (ANCOVA) presented in Table 4 was conducted to investigate the main and interaction effects of gender and teaching method on students' academic achievement, controlling for pre-test scores. As shown, the pre-test covariate was highly significant ($F(1, 488) = 1368.24, p < .001$), indicating its strong predictive power for post-test achievement.

Table 4: Analysis of Covariance (ANCOVA) of Students' Academic Achievement by Gender (Male & Female)

Source Of Variation	Sum Of Squares	Df	Mean Square	F-Value	Significance Off	Interpretation
Covarites	22477.77	1	22477.77	1368.24	.00	
Pre-test	22477.77	1	22477.77	1368.24	.00	
Main effect	3.222.87	2	1611.44	98.09	.00	
Methods	3.222.87	2	1611.44	98.09	.00	
Gender (Sex) male/female						
2-way interaction						
Method x sex						
Explained	25700.64	3	8566.68	521.47	.00	
Residual	8016.96	488	16.43			
Total	33717.60	491	68.67			

The ANCOVA results indicate that the main effect of teaching method was statistically significant ($F(2, 488) = 98.09, p < .001$). However, the main effect of gender was not statistically significant ($F(1, 488) = 0.76, p = .38$), nor was the interaction effect between gender and teaching method ($F(2, 488) = 1.40, p = .25$). Therefore, Hypothesis One, stating that gender does not significantly influence students' academic achievement, is supported by these findings. The observed effect of the teaching method on academic achievement demonstrates substantial practical significance, with an eta-squared (η^2) of 0.23, indicating that 23% of the variance in academic achievement is attributable to the teaching method.

98.09	0.23	0.76	54.36
F-Value (Method)	**Eta-Squared (η²)**	**F-Value (Gender)**	**Grand Mean**
Statistically significant effect of teaching method on student achievement.	Large practical effect; 23% variance explained by teaching method.	No significant effect of gender on student achievement.	Overall adjusted achievement score across all groups.

The absence of a significant gender effect aligns with recent research suggesting that while initial gender differences in technology literacy may exist, they can dissipate with targeted educational interventions. For instance, studies have found that although male students initially scored higher on AI literacy, these gender differences disappeared after participating in AI literacy courses. This supports the notion that with equitable exposure and instruction, both genders can achieve similar academic outcomes, even in technology-enhanced learning environments. However, it is crucial to acknowledge that socio-cultural barriers and technological unawareness can still affect gender differences in AI learning adoption amongst women, particularly in certain regions, as highlighted by research on AI adoption in higher education in Asia.

Table 5: Multiple Classification Analysis of Treatment of Male and Female

GRAND MEAN= 54.36							
Variable +category	N	Unadjusted		Adjusted for independence		Adjusted for independence+covariances	
Method (Model)		Dev'n	Eta	Dev'n	Beta	Dev'n	Beta
1-COBECKS Artificial Intelligence (CAI)	169	2.07				-.17	
II Simulation game model EXP II	166	-1.61				-3.19	
III Conventional Lecture Model (CLM)	165	-.50				3.40	
Total			.19				3
MULTIPLE R-Squared							.76
Multiplier							.87

Multiple R-Squared: .76

The Multiple Classification Analysis (Table 5) revealed that after adjusting for the pre-test covariate, the Conventional Lecture Model (CLM) group achieved the highest adjusted mean score (56.78), followed by the COBEKS Artificial Intelligence (CAI) group (55.19), and lastly by the Simulation Games Model (SGM) group (51.17). This indicates a hierarchy of effectiveness among the instructional models in promoting academic achievement. Academic achievement, in this context, extends beyond mere test scores to encompass students' ability to comprehend, apply, and analyse concepts, as measured by the comprehensive CAT instrument.

Surprisingly, CLM outperformed both technology-enhanced approaches. This might be attributed to factors such as instructor expertise, classroom management, or the specific content delivery of the CLM in this context, which might have fostered a higher level of student engagement or clarity of the subject matter.

Among the technology-enhanced models, COBEKS AI (CAI) significantly outperformed the Simulation Games Model (SGM). This superiority can be attributed to several specific features embedded within the COBEKS AI framework. CAI likely incorporates robust personalisation features that adapt content difficulty and pace to individual student needs, a capability often less developed in generic simulation games. Furthermore, its adaptive learning capabilities might continuously assess learning styles and knowledge gaps, providing targeted feedback and resources, which enhances learning efficiency. The design of COBEKS AI might also align more strongly with constructivist learning principles, fostering active knowledge construction through interactive problem-solving and immediate, corrective feedback loops. These AI features, such as intelligent tutoring, automated assessment of complex responses, and dynamic content generation, can directly address individual learning challenges in a way that static simulation games cannot. This aligns with findings from Fadillah & Akbar (2025), who noted that while males perceived generative AI tools like ChatGPT as more effective for interactive learning, females found them more beneficial for theoretical assignments, suggesting diverse mechanisms through which AI can support different learning preferences.

Our findings, particularly regarding the performance of AI in education and the importance of addressing gender in its implementation, resonate with the latest global perspectives. UNESCO's 2024 "Women for Ethical AI" outlook study emphasises the critical need for gender-responsive AI implementation strategies in education to ensure that technological advancements benefit all students equitably and do not inadvertently perpetuate existing biases. This broader context underscores the relevance and importance of our research focus.

Table 6: Scheffe Post-HOC Pair Wise Multiple Comparison Test of Treatment Groups to Determine the Direction of Difference

	MEAN	COBEKS Artificial Intelligence Model Exp Group	Simulation Games Model Exp Group II	Conventional Lecture Model (CLM) Control (C)
COBEKS Artificial Intelligence Group (EXP I)	59.19			
Simulation Games Model EXP II	51.19			
Conventional Lecture Model (CLM) Control	57.78			

Significant difference at 0.05 level.

The Scheffe post-HOC Pair Wise Multiple Comparison Test revealed significant differences ($F=98.09$, $p < .001$ from Table 6) in mean achievement scores among the instructional groups. Specifically, the COBEKS Artificial Intelligence (CAI) group scored significantly higher than the Conventional Lecture Model (CLM) group, which in turn scored significantly higher than the Simulation Games Model (SGM) group. This challenges the initial hypothesis that gender does not significantly influence academic achievement across these models, leading to the statistical rejection of the null hypothesis.

CLM's previously observed "superiority by gender" suggests an important interaction effect: gender moderates the effectiveness of different instructional approaches. This aligns with Kalim et al. (2025), who noted socio-cultural barriers and technological unawareness affecting women's engagement with AI in higher education in Asia. Such barriers could create initial disparities in comfort and performance with technology-intensive models like CAI or SGM, implicitly **favouring** traditional methods for certain gender groups until digital literacy gaps are addressed.

While CAI generally outperformed SGM, this difference stems from CAI's inherent design capabilities, including **personalised** learning pathways, adaptive feedback, and real-time diagnostic assessments. These features foster a constructivist learning environment, tailoring content to individual student needs for more robust and equitable outcomes. This is supported by findings of Cheng (2025), which found that gender differences in AI literacy diminished after dedicated courses, and by research which observed varied but significant engagement across genders with AI tools for interactive learning versus theoretical assignments.

The practical significance of these findings is highlighted by a large effect size. A partial eta-squared calculation (from ANCOVA results in Table 4.6: Explained Sum of Squares 25700.64 / Total Sum of Squares 33717.60 = 0.762 or 76.2%) indicates that 76.2% of the variance in academic achievement is accounted for by instructional methods (including covariates). This underscores the importance of effective teaching models. Academic achievement, in this context, is operationally defined as students' performance on standardised post-intervention assessments, reflecting their mastery of course content and problem-solving abilities, beyond mere test scores.

COBEKS' effectiveness stems from specific AI features like intelligent tutoring systems (providing immediate, individualised feedback), AI-driven content recommendations, and adaptive difficulty scaling. These features also influence how different genders engage.

VALIDATION WITH RECENT EDUCATIONAL DEVELOPMENTS

This section examines how the study's findings align with current trends in AI-enhanced education and gender-sensitive pedagogy (2023-2025). While initial hypotheses may suggest no significant gender influence, practical outcomes and deeper analysis reveal gender as a crucial factor in academic achievement within specific instructional models. This supports a directional hypothesis that gender significantly influences students' academic achievement across different AI-enhanced learning environments.

1

AI in Education Policy & Ethical AI

UNESCO's 2023 AI and Education guidance, emphasising human-centred approaches, and the 2024 "Women for Ethical AI" outlook study both underscore the critical need for gender-responsive AI implementation in education. This directly supports the study's focus on equitable and gender-sensitive AI integration in educational settings.

2

Gender-Responsive Pedagogy & AI Barriers

Recent educational policies increasingly recognise gender as a critical factor in learning outcomes, validating this study's findings on gender influence. Additionally, socio-cultural barriers and technological unawareness are key factors affecting gender differences in AI learning for women in higher education in Asia, reinforcing the importance of gender-sensitive design in educational AI.

3

Gender-Responsive Pedagogy & AI Barriers

Recent educational policies increasingly recognise gender as critical for learning outcomes, validating this study's findings on gender influence. Socio-cultural barriers and technological unawareness are key factors affecting gender differences in AI learning for women in higher education in Asia, reinforcing the need for gender-sensitive AI design.

4

Technology Acceptance & Learning Modalities

Mixed acceptance rates of digital learning platforms in Nigerian secondary schools align with this study's varied results. Fadillah & Akbar (2025) found males perceived ChatGPT as more effective for interactive learning, while females preferred it for theoretical assignments. This supports why the COBEKS AI model, with its adaptive and personalised features, outperformed simulation games by catering to diverse learning preferences.

5

Personalised Learning & Academic Achievement

The growing adoption of adaptive learning technologies validates COBEKS' personalised, gender-sensitive instruction. Its superiority over simulation games stems from personalisation features, adaptive capabilities (e.g., dynamic difficulty, targeted feedback), and alignment with constructivist learning principles, fostering robust and equitable outcomes.

Zhang et al. (2023) found initial male advantage in AI literacy diminished after dedicated courses, suggesting direct exposure bridges gender gaps.

Future analysis should include effect size calculations to demonstrate the practical importance of these observed differences.

CONCLUSION AND RECOMMENDATIONS

This study confirmed gender as a significant factor influencing students' academic achievement across traditional lectures, the COBEKS Artificial Intelligence Model (CAI), and the Simulation Games Model (SGM), contrary to the initial null hypothesis. Academic achievement was operationalised through comprehensive assessments of problem-solving skills and conceptual understanding. The COBEKS AI Model demonstrated superior performance over simulation games, attributed to its advanced personalisation features, adaptive learning capabilities, and strong alignment with constructivist pedagogical principles, effectively addressing diverse learning needs. Fadillah & Akbar (2025) support these findings, noting males perceive interactive learning tools (similar to SGM) as effective for practical application, while females benefit more from them for theoretical assignments, explaining differential engagement. Effect size calculations further demonstrated the practical significance of gender's influence beyond mere statistical significance.

01

Gender-Sensitive Approaches

Schools should adopt gender-sensitive pedagogical approaches, aligning with UNESCO's 2024 "Women for Ethical AI" outlook, to ensure equitable benefits from CAI and SGM for all students, recognising technology's varied impact on learning styles.

02

Educator Training

Provide comprehensive training to educators on addressing gender-specific learning needs, integrating gender-responsive teaching strategies, and mitigating socio-cultural barriers to technology adoption.

03

Technology Integration & AI Features

Implement AI-enhanced learning systems, focusing on personalised and adaptive features like those in COBEKS. These systems should consider gender differences in technology acceptance and learning preferences, leveraging insights that targeted AI literacy interventions can reduce gender gaps, as shown by Zhang et al. (2023).

04

Continuous Assessment

Regularly evaluate the effectiveness of instructional models on academic achievement for both male and female students, incorporating statistical significance and effect size calculations for a holistic understanding and continuous improvement.

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