

**HUMAN COMPUTER INTERACTION APPLICATIONS: AN APPROACH TO IMPROVING TERTIARY INSTITUTIONS STUDENTS LEARNING OUTCOME****<sup>1</sup>Rahamon, S. O., <sup>2</sup>Owoyemi S. O.**<sup>1</sup>*Department of Computer Science Federal College of Education, Abeokuta, Ogun State*<sup>2</sup>*Department of Science and Technology Education, Faculty of Education, Lagos State University***Abstract**

*This study investigated Human Computer Interaction as an approach to improving learning in tertiary institutions Ogun State. A descriptive survey research design was adopted and simple random sampling method was used to select One hundred and fifty students from the selected three levels of tertiary institutions in Abeokuta Ogun. The study made use of four research questions with a self-constructed questionnaire to elucidate respondents' opinions. Data obtained were analyzed using frequent count, simple average and mean statistics method Likert Scale based. Findings revealed that **smart-boards/interactive whiteboards are only HCI applications used in the tertiary institutions while** collaboration tools, clicker systems, chatbots and voice assistants, brain-computer interfaces (BCIS), robotic, digital tablets with styluses, motion capture systems and brain computer interface are not available in the tertiary institutions. Also students perceived that HCI tools make concepts easier to understand, and increases student interest and motivation, and most students and tutors inadequate HCI tools skills usage, outdated hardware or insufficient computational resources, additional devices procuring cost as well as overwhelmed volume of information presented through HCI applications limit HCI integration. Based on the findings of the study, the researcher therefore recommends that institutions should develop comprehensive training programs aimed at enhancing digital literacy and HCI tool proficiency among students and lecturers. Workshops, tutorials, and hands-on sessions that can empower students to engage more effectively with technology for improved their academic outcomes.*

Keywords: HCI, Learning, Tertiary Institutions and BCIS

**Introduction**

The use of computers, mobile devices, and the Internet now by developing countries users has reached highest level and is expected to move forward since their access to technology has improved (Poushter, 2016). As the seamless integration of technology into common tasks such as shopping, reading, and finding directions, the digital revolution has profoundly affected daily living, evident in the ubiquity of mobile devices (Anderson & Horrigan, 2016).

Carroll, (2020) sees Human-Computer Interaction (HCI) is an interdisciplinary field that focuses on the design, development, and evaluation of interactive systems and the study of how humans engage with these systems. It draws from multiple disciplines such as computer science, cognitive psychology, design, sociology, and ergonomics to optimize the interaction between people and technology and explores both the technological aspects (user interfaces, algorithms, and hardware)



and the human aspects (cognition, emotion, and behavior) to improve user experience, productivity, and overall system efficiency.

HCI has of today is a critical component in developing user-centered technologies, such as smartphones, wearable devices, virtual and augmented reality, and artificial intelligence (AI) systems. It surfaced in the early 1980s, in the study of human factors and ergonomics, and expanded rapidly due to the accretion of digital devices, mobile computing, and the internet (Bannon, 2019).

Adaptive learning, which allows educational software to adjust to individual student needs, is one of the key contributions of HCI to modern education. HCI in education primarily aimed to improve the usability, accessibility, and effectiveness of educational software and tools to aligning with students' cognitive processes and learning styles (Sharp, Rogers, & Preece, 2007). Adaptive systems provide tailored feedback, suggestions, and resources to optimize learning outcomes (Kulik & Fletcher, 2016).

An HCI facility is playing an increasing important role in education for both lecturers and students. The use of HCI enable each student to develop at his or her own pace and make the whole learning process flexible (Encarta, 2014). Landu (2017) the use of HCI in classroom instruction helps tutors to take care of the learner's individual ability as there are the gifted, the average and the slow learners.

Human-Computer Interaction (HCI) has become increasingly relevant in higher education due to the growing integration of technology in learning environments. HCI in tertiary institutions are crucial for enhancing the learning experience, improving academic outcomes, and preparing students for a digital-driven workforce Saffer (2013).

HCI significantly influences students in tertiary institutions and in shaping modern education as HCI principles are more intuitive, engaging, and efficient, allowing students to focus on learning rather than struggling with the technology itself (Norman, 2013), well-designed interfaces that incorporate HCI principles significantly improve the accessibility of course materials, making education more inclusive, especially for students with disabilities (Kinshuk, 2016), HCI research in adaptive systems tailors the learning experience to individual student needs, creating personalized educational pathways (Chi & Wylie, 2014),

Dillenbourg (2016) found that students using well-designed collaborative platforms performed better in group tasks and developed stronger interpersonal and communication skills, creating an inclusive learning environment where students with disabilities are increasingly participating in higher education. HCI-driven tools such as online discussion forums, collaborative software, and digital whiteboards facilitate peer-to-peer interaction and group work are designed to support real-time communication, file sharing, and collaborative editing, which are crucial for group projects and research work (Suthers, 2017).

Despite HCI advances, several challenges remain in the design, implementation, and adoption of HCI technologies across various sectors, including education, healthcare, and business. These challenges arise from technical, cognitive, and social dimensions, posing obstacles to effective



HCI design and interaction. Some of the key challenges associated with HCI include, HCI systems grow more advanced, with features like artificial intelligence (AI) and machine learning (ML) becoming more prevalent, it becomes more difficult to design interfaces that are simple yet functional for novice users (Zhou et al., 2022), Cognitive overload where complex learning management systems (LMS) or virtual learning environments (VLE) may require users to navigate through many menus, icons, or instructions (Sweller et al., 2019).

On implementation, many systems still lack appropriate accommodations for users with visual, auditory, or motor impairments, designing interfaces that include alternative input methods for users with specific disability is essential to ensure equal access, yet many systems fail to incorporate such features comprehensively (Lazar et al., 2021).

On adoption related, creating systems that account for users' emotional and social needs, not just their cognitive or functional requirements are often fall short in understanding nuanced emotions or responding empathetically, **Adapting to Emerging Technologies** such as AI, virtual reality (VR), augmented reality (AR), and the Internet of Things (IoT)—presents a continual challenge for HCI designers, VR and AR interfaces present unique challenges in terms of spatial interaction and user disorientation, while AI systems may introduce issues related to trust and transparency (Johnson et al., 2021).

### **Statement of the Problem**

Kulik & Fletcher, (2016), despite significant enhancement of adaptive learning technologies on academic performance and student satisfaction, many institutions lack the infrastructure or understanding to implement such technologies effectively. HCI principles through adaptive learning technologies could bridge personalized learning experiences traditional educational systems often fall short of providing to meet modern educational systems.

Students use mobile devices for learning and believe that technology can help them achieve learning outcomes and better prepare them for a workforce that is increasingly dependent on technology (Chen, Seilhamer, Bennett, & Bauer, 2015). The work seeks to examine the Human-Computer Interaction (HCI) applications available and integrated into the learning processes of students, the impact on students' academic performance, students' perceptions and attitudes towards the use of HCI applications in their learning activities and the challenges facing HCI on students' academic performance in the tertiary institutions.

### **Research Questions**

1. What are the available integrated Human-Computer Interaction (HCI) applications into the learning processes of students in tertiary institutions?
2. What are the expected impacts of HCI applications on students' academic performance in tertiary institutions?
3. What are the students' perceptions and attitudes towards the use of HCI applications in their learning activities?
4. What are the challenges facing HCI applications integration on students' academic performance in tertiary institutions?

### **Methodology**

This research study made use of descriptive research design. The population of the study comprised of all final year students in the three different categories of public tertiary institutions in Abeokuta, Federal College of Education, Mashood Abiola Polytechnic and Federal University of Agriculture, Ogun State. The population for this study consisted of one hundred and fifty (150) randomly selected students from Three (3) levels of tertiary institutions in Abeokuta.

The instrument for the research work was a self-constructed questionnaire. The questionnaire made up of two (2) sections. The Section “A” consists of the respondents’ Bio-data such as institution name, faculty/School, Gender, and Computer proficiency level while the section “B” comprised of structured items to elucidate responses from which respondents were required to pick the options of their best choice using the Renis Likert scale of 4 points. The section however, ranges from SA: Strongly Agree, A: Agree, SD: Strongly Disagree, D: Disagree, available, and Non available. The items on the questionnaire investigated negative and positive responses based on the subject matter.

### Validity and Reliability of the Research Instrument

The questionnaire constructed was tested during the pilot survey conducted with the target population but respondents were not part of the drawn sample used for the real study. Reliability is regarded as the extent to which a measurement is free from random error. Possible problems that were likely to be encountered during the research were noted and rectified.

### Data Analysis

Data collected were analyzed using descriptive statistics of simple percentages while the mean method was used to analyze the research statements. Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1 Calculations:  $(4+3+2+1)/4 = 2.5$ . Any mean value which is less than 2.5 hereby rejected the research statement while a mean value which is exactly 2.5 or is greater than the 2.5 accepted and agreed to the research statement.

**Research question 1:** What are the available integrated Human-Computer Interaction (HCI) applications into the learning processes of students in tertiary institutions?

Table 1: For research question one responses

N/S	STATEMENT	A	NA
1	Collaboration tools (e.g., Zoom)	43 (28.7%)	107 (71.3%)
2	Clicker Systems	57 (38%)	93 (62%)
3	Chatbots and voice assistants (e.g Siri, Google Assistant)	61 (40.7%)	89 (59.3%)
4	Brain-Computer Interfaces (BCIs)	24 (16%)	126 (84%)
5	Robotics	14 (9.3%)	136 (90.7%)
6	<b>Smartboards/Interactive Whiteboards</b>	102 (68%)	48 (32%)
7	<b>Digital Tablets with Styluses</b>	26 (17.3%)	124 (82.7%)
8	Motion Capture Systems	19 (12.7%)	131 (87.3%)
9	Brain-Computer Interfaces (BCIs)	39 (26%)	111 (74%)

10	Interactive board	118 (78.7%)	32 (21.3%)
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**Source: Field Survey, 2024**

Table 1 above indicates that 43 (28.7%) respondents said that HCI collaboration tools (e.g., Zoom) is available while 107 (71.3%) said not available for teaching in tertiary institutions, also 57 (38%) respondents agreed with clicker systems as HCI available in the institutions while 93 (62%) disagreed. 61 (40.7%) respondents agreed that Chatbots and voice assistants (e.g., Siri, Google Assistant) is part of HCI application used in tertiary institutions while 89(59.3%) disagreed, in addition, 24 (16%) respondents agreed that Brain-Computer Interfaces (BCIs) is used in tertiary institutions while 126 (84%) disagreed.

The study further revealed that 14 (9.3%) respondents agreed that robotics is available as part of HCI application for teaching while 136 (90.7%) disagreed, also, 102(68%) respondents agreed availability of **smart-boards/interactive whiteboards** while 48(32%) disagreed. Furthermore, 26 (17.3%) respondents agreed that **digital tablets with styluses** is part of HCI facilities in the institutions while 124 (82.7%) disagreed with the statement. 19 (12.7%) agreed on the usage of motion capture systems, while 131 (87.3%) disagreed. Also, 39 (26%) respondents agreed with the brain-computer interfaces (BCIs) while 111 (74%) disagreed with the statement. Lastly, 118 (78.7%) agreed that interactive board is used as part of HCI for teaching in higher institutions while 32 (21.3%) disagreed with the statement.

**Research question 2:** What are the expected impacts of HCI applications on students' academic performance in tertiary institutions?

Table 2: For research question two responses

S/N	ITEM	SA (4)	A (3)	SD (2)	D (1)	$\sum fx$	$X = \sum fx/f$	Remark
11.	HCI tools like smartboards make complex concepts easier to understand by providing visual and interactive representations.	72	47	19	12	150	3.19	Agreed
		288	141	38	12	479		
12.	The use of game-like elements in learning platforms increases student interest and motivation.	55	47	32	16	150	2.94	Agreed
		220	141	64	16	141		
13.	The use of screen readers and speech-to-text tools devices make education accessible to students of all ages.	74	56	11	9	150	3.30	Agreed
		296	168	22	9	495		
14.	HCI applications like simulation-based learning enable critical thinking and problem-solving skills by placing students in realistic scenarios	84	53	13	-	150	3.47	Agreed
		336	159	26	-	521		
15.	HCI tools like digital planners and AI-powered assistants help students organize their schedules and track deadlines.	93	40	12	5	150	3.47	Agreed
		372	120	24	5	521		

**Source: Field Survey, 2024 N = 150 Decision Rule = 2.50 Weighted Mean = 3.27**

Table 2 above shows the responses on the expected impact of HCI applications on students' academic performance in tertiary institutions. It was observed that the means of items 11 to 15

were higher than the decision mean and also the weighted mean 3.27 for the five items was also found to be higher than that of the decision mean ( $3.27 > 2.50$ ) which indicates that all the items were accepted by the respondents.

**Research question 3:** What are the students' perceptions and attitudes towards the use of HCI applications in their learning activities?

Table 3: For research question three responses

S/N	ITEM	SA (4)	A (3)	SD (2)	D (1)	$\sum fx$	$X = \sum fx/f$	Remark
16.	Students often perceive HCI applications as engaging and interactive in the classroom.	77	44	9	20	150	3.18	Agreed
		308	132	18	20	478		
17.	HCI tools, like virtual labs or interactive diagrams, help students visualize abstract or complex concepts, improving their comprehension and retention.	85	54	8	3	150	3.47	Agreed
		340	162	16	3	521		
18.	HCI applications empower students to take control of their learning.	96	42	9	3	150	3.54	Agreed
		384	126	18	3	531		
19	HCI applications facilitate group discussions, peer reviews and promote collaboration in the classroom.	78	49	16	7	150	3.32	Agreed
		312	147	32	7	498		
20.	Students prefer face-to-face interactions with teachers and peers, feeling that HCI applications may lack the personal touch that human instructors provide	83	52	13	-	150	3.43	Agreed
		332	156	26		514		

**Source: Field Survey, 2024 N = 150 Decision Rule = 2.50 Weighted Mean = 3.39**

Table 3 above shows the responses on the students' perceptions and attitudes towards the use of HCI applications in their learning activities. It was observed that the means of items 16 to 20 were all higher than the decision rule which indicates that all the items were accepted by the respondents. Also the weighted mean 3.39 was found to be higher than that of the decision rule 2.50 ( $3.39 > 2.50$ ). Thus the students' perceptions and attitudes towards the use of HCI applications in their learning activities were relevant and accepted.

**Research question 4:** What are the challenges facing HCI applications integration on students' academic performance in tertiary institutions?

Table 4: For research question four responses

S/N	ITEM	SA (4)	A (3)	SD (2)	D (1)	$\sum fx$	$X = \sum fx/f$	Remark
21.	Many students lack the necessary skills to interact effectively with HCI tools.	67	54	9	20	150	3.12	Agreed
		268	162	18	20	468		
22.	Outdated hardware or insufficient computational resources in institutions limit the functionality of HCI applications.	75	54	18	3	150	3.34	
		300	162	36	3	501		
23.	The cost of procuring devices, software licenses, or upgrades may be prohibitive for both students and institutions.	96	42	9	3	150	3.54	Agreed
		384	126	18	3	531		
24.	Students may feel overwhelmed by the volume of information presented through HCI applications.	88	49	6	7	150	3.45	
		352	147	12	7	518		
25.	Inadequate training for educators in using HCI tools effectively is a barrier.	73	52	23	2	150	3.31	Agreed
		292	156	46	2	496		

**Source: Field Survey, 2024 N = 150 Decision Rule = 2.50 Weighted Mean = 3.35**

Table 4 above shows the responses on the challenges facing HCI applications on students' academic performance in tertiary institutions. It was observed that the means of items 21 to 25 were all higher than the decision mean which indicates that all the items were accepted by the respondents. It was also observed that the weighted mean for the five items 3.35 was higher than that of the decision mean ( $3.35 > 2.50$ ). This means that the items on the challenges facing HCI applications on students' academic performance in tertiary institutions were relevant and accepted.

### Discussion of findings

This study investigates the available integrated Human-Computer Interaction (HCI) applications in the learning processes of students, expected impacts of HCI applications on students' academic performance, the students' perceptions and attitudes towards the use of HCI applications in their learning activities and the challenges facing HCI applications on tertiary institutions students' academic performance. The respondents data collected from the study population were presented on table using descriptive statistics of simple percentages while the mean method was used to analyze the data collected.

From the research question 1 response on the available integrated Human-Computer Interaction (HCI) applications into the learning processes of students. Smart-boards/interactive whiteboards are the HCI applications are available and used in the tertiary institutions while others such as collaboration tools (e.g., zoom), clicker systems, chatbots and voice assistants (e.g., Siri, google assistant), brain-computer interfaces (BCIS), robotic, digital tablets with styluses, motion capture systems and brain computer interface are not available integrated Human-Computer Interaction (HCI) applications into the learning processes.



With research question 2 on the expected impacts of HCI applications on their academic performance, they believed that HCI tools like smart boards and simulation-based learning enable critical thinking and problem-solving skills, The use of game-like elements in learning platforms, screen readers and speech-to-text tools devices make education accessible while digital planners and AI-powered assistants help students organize their schedules and track deadlines.

The research questions 3 on the students' perceptions and attitudes towards the use of HCI applications in their learning activities, they often perceive HCI applications as engaging and interactive in the classroom activities, HCI tools like virtual labs or interactive diagrams help them visualize abstract or complex concepts, improving their comprehension and retention, facilitate group discussions, peer reviews and promote collaboration in the classroom, but majority prefer face-to-face interactions with teachers and peers, feeling that HCI applications lack the personal touch that human instructors provide.

Research question 4 on the challenges facing HCI applications integration on students' academic performance in tertiary institutions, revealed that many of them lack the necessary skills to interact effectively with HCI tools, outdated hardware or insufficient computational resources in institutions limit the functionality of HCI applications, the cost of procuring devices, software licenses, or upgrades may be prohibitive for both students and institutions, students may feel overwhelmed by the volume of information presented through HCI applications and inadequate training for educators in using HCI tools effectively are barriers.

### **Conclusion**

The findings have shown that smart-boards/interactive whiteboards are the HCI applications are available and fully integrated in their learning activities but while collaboration tools, clicker systems, chatbots and voice assistants, brain-computer interfaces (BCIS), robotic, digital tablets with styluses, motion capture systems and brain computer interface are not available integrated. Students believed that HCI tools enable critical thinking and problem-solving skills, make education accessible and help students organize their schedules and track deadlines.

They perceived HCI applications as engaging and interactive in the classroom activities, but majority prefer face-to-face interactions with teachers and peers, feeling that HCI applications lack the personal touch expected of human instructors. Many students and tutors lack the necessary skills to effectively use HCI tools, outdated hardware or insufficient computational resources, the cost of procuring devices for students and institutions limit HCI applications with students feeling overwhelmed by the volume of information presented through HCI applications.

### **Recommendations**

Based on the research findings, the study therefore recommended that;

1. There is need for awareness of other HCI applications applicable in tertiary institutions beyond smart-boards/interactive whiteboards to improve students' learning outcomes.
2. The students need more usage training on the use of HCI applications for their academic activities since they shared believe of the positive impacts on the learning outcomes.
3. Institutions should organize adequate trainings or workshops on the use of HCI applications for their tutors for proper and full integration for lectures delivery to improve their students learning outcomes.



4. Workshops, tutorials, and hands-on sessions that can empower students to engage more effectively with technology for improved their academic outcomes.

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