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Challenges of Students and the Mediating Effect of Acceptance, Interactivity and LMS on Integration of Technology

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ABSTRACT

Although the phenomenon of technology is gradually being integrated into tertiary education in Ghana, challenges impeding effective integration are endemic. A systematic review of the challenges confronting students indicates a lack of network and connectivity, lack of Internet bandwidth and data bundles, inadequate training, inadequate technical support, and lack of hardware and software, among others, as key barriers to integration of technology into academic programmes in public universities in Ghana. Using the Constructivist and Positivist paradigms, this study adopted the quantitative approach with responses on 1704 questionnaires collected from level 400 students in six (6) accredited public universities. Adopting the regression analysis approach with testing of ten hypotheses, the results were analyzed with PLS-SEM. The study found that the challenges of students, directly and indirectly, impact the integration of technology when the linkage is mediated by Acceptance, Interactivity and LMS usage. Furthermore, students' Acceptance and Adjustment to adopt technology and the use of the LMS, are key predictors of the integration of technology into academic programmes in the public universities in Ghana. However, Interactivity among students and lecturers do not have any significant impact on the linkage between challenges of students and the Integration of technology.

Keywords: *Challenges; Acceptance and Adjustment; Interactivity; Learning Management Systems; Integration of Technology.*

INTRODUCTION

Integration of technology into the curriculum is a huge issue in educational technology and requires urgent attention to ensure a smooth infusion of learning technologies into academic programmes. Integration of technology is an ontological phenomenon that must be carefully studied and understood within the context of higher education. Without a doubt, developing nations have made significant progress in embracing digital technology platforms for education, particularly the widespread application of e-learning in teaching and disseminating knowledge. Technology is gradually being integrated into all sectors of the educational ecosystem. Within the higher education ecosystem, students are expected to possess some ICT skills before they are admitted or complete tertiary education. Integration of technology into higher education is therefore imperative and the key stakeholders - students, lecturers, policymakers, and IT staff, are mandated to ensure the smooth integration of technology into the curriculum to facilitate and enhance or transform the teaching and learning process. In the process, students encounter numerous challenges and obstacles, which begin with their own beliefs and degree of acceptance and adjustment to the use of technological innovations. Quite a considerable amount of these innovations include the Learning Management Systems (LMS) with integrated tools for teaching and learning. These tools are also designed and even customized to facilitate interactivity among students and lecturers (van Dijk, 2006, Anderson, 2004). This study, therefore, considered five main constructs: 'challenges of students', 'acceptance and adjustment', 'learning management systems usage', 'interactivity', and

'integration of technology' from previous studies (Mercader, 2020; Dinc, 2019; Tanveer, 2018; and Kumar & Ben-Kei, 2016). The essence is to investigate and assess the impact that these constructs have on the integration of technology into academic programmes in public universities in Ghana.

The purpose of this research is to examine the challenges of students and the impact on the Integration of technology and to propose a conceptual framework for the infusion of technology within the higher education context**.** In many universities in Ghana, technology is being used in diverse ways. Generally, the use of technology has focused on computers and their components, software applications, and online learning management systems and platforms (Fedora, 2015). Comparatively, traditional pedagogies have been preferred and practised for decades. Currently, a real difficulty facing students is the lack of infrastructure, lack of network and connectivity, cost of Internet bundles and devices, inadequate training, and technical support systems. Notwithstanding, university teachers and students are gradually adapting to the integration of technology through distance education. According to Ankomah-Asare, Nsowa-Nuamah & Larkai, (2016), the trends showed that the University of Education, Winneba (UEW) and the University of Cape Coast (UCC) together accounted for over 70% of all distance enrolment in public universities in Ghana at that time.

Distance enrolment has seen a 39.4% increase in the last decade (2010-2021). Recent studies concerning the integration of technology in HEIs in Ghana have proven that perceptions, attitudes and challenges of students are a potential threat to the success of the Integration of Technology. According to Boison (2019), ICTs are perceived negatively and positively by students. Negative perceptions included students not being enthused about subjects which required the use of computers. Guillén-Gámez et al., (2020) have reported that despite having a great responsibility to train students in digital technologies based on their continual growth, university teaching staff have an average attitude towards the use of ICT and that, "attitudes have a decisive influence on decisions regarding whether to use ICT or not." (p.11). This study, therefore, sought to examine the challenges of students and the impact on the integration of technology in academic programmes in the six top public universities in Ghana. The objectives and research questions were primarily to investigate whether student challenges in technology adoption and adaptation impact the integration of technology. More specifically the research aims and questions are as follows:

Research Aims

- To examine the challenges confronting students and the impact on the integration of technology.
- To assess the mediating role of acceptance and adjustment, interactivity and LMS on the integration of technology.
- To develop a conceptual framework for the integration of technology, through the lens of the Technology Integration Matrix (TIM).

Research Questions

- To what extent do the challenges confronting students impact the integration of technology?
- To what extent do the mediating variables impact the relationship between the challenges of students and the integration of technology?
- What are the major constructs that are ideal for the development of a proposed conceptual framework?

Previous studies in Ghana have to some extent touched on the impact of challenges on the integration of technology in academic programmes in public universities. Hence, this article sought to address the knowledge gap that pertains to the mediating effects of students' acceptance and adjustment to use technology, interactivity and LMS usage, on the integration of technology.

LITERATURE REVIEW

In the context of challenges faced by students, Mercader (2020) noted seven key obstacles to integrating technology: *technophobia, time constraints, lack of planning, a lack of incentives, a lack of assessment, work saturation, and the university accreditation model*. All these affect the integration of technology. According to Boison (2019), despite the revelation that ICTs are perceived negatively and positively by students, the positive outweighed the negative. Challenges relating to *training* pose more serious negative effects on the infusion of technologies in higher institutions in Ghana. Obiri-Yeboah et al., (2013) earlier observed a lack of affordable and dependable connectivity with insufficient bandwidth and the unwillingness of students to use ICT, coupled with unreliable electricity supply directly affects the integration of technology. Recent studies in Higher Educational Institutions (HEIs) in Ghana have proven that the challenges of learners are a potential threat to the success of integration. Johnson et al., (2016) classified the threats to technology integration into first-order barriers and second-order barriers and stated that first-order barriers included issues surrounding insufficient equipment or connectivity, inadequate training, inadequate technical support, and organizational/peer support. Second-order barriers included educators' attitudes and beliefs, teacher resistance and lack of teachers' skills and knowledge.

Tanveer (2018) highlighted integration barriers and categorized them into three primary categories: technological, administrative, and pedagogical. Major obstacles included but were not limited to a lack of e-learning resources to manage networked classes and electronic assessments; faculty who are not as technologically advanced; unreliable technology; a lack of technical expertise and confidence on the part of both teachers and students. Various findings suggest that the incorporation of technology and its related applications in academic programs must consider the specific environment at stake (Al-Mahmood & Mc Coughlin, 2004), including cultural issues that are ingrained in long-standing legacies and may present significant obstacles to the integration of learning technologies in academic programmes at HEIs. Aldowah et al., (2015) investigated the barriers and challenges of using e-learning and attitudinal hampering and cultural barriers were some of the challenges discovered. Pelgrum (2001) classified some of these barriers to ICT integration as lack of tools and material (for example, computers and software) as well as non-material (for example, lack of teacher competencies and training). Ertmer (1999) also categorized barriers as external where students found it difficult to access hardware and software, and internal where teacher beliefs about teaching impeded the integration process. Likewise, Herzig (2004) affirmed that the main barriers to ICT integration which affected students were a lack of experts and the prerequisites for teacher training. According to Bingimlas (2009), other significant obstacles confronting students were a lack of skill, a lack of confidence, and a lack of access to resources.

Parry (2005), Russo & Arndt (2010), discussed the existence of moral and legal questions and issues brought about by technology in the classroom, where it was noted that the proliferation of mobile devices with digital capabilities was causing major headaches for local governments and educational institutions. The difficulties, in the opinion of Fox (2018), included student copyright infringement (Newton, 2013) and sexting in schools (Russo & Arndt, 2010). According to Siddiquah & Salim (2017), load shedding, the lack of necessary software, virus threats, Internet signal issues, slow computer speeds, restricted Internet access, a lack of technical support, corrupt software, unreliable computer performance, and poor computer conditions were the biggest obstacles higher education students faced when using ICT. Siddiquah & Salim (2017) further showed that students

spend more time on computers for recreational and other purposes rather than academic purposes. Looking at these findings on students' challenges there is a need to examine and understand the challenges associated with computer-assisted instruction, the challenges of skills, and the confidence to use computers and access Internet resources among Ghanaian students. This gap is explored in the present study. The theories underpinning this study are discussed below.

The Technology Integration Matrix (TIM) was introduced by the Florida Center for Instructional Technology (FCIT, 2017) at the University of South Florida, as a guide for teachers and administrators in the practice of integrating technology. The TIM is based on the theory of social constructivism in which new learning occurs when students interact with each other to build new knowledge or gain new understanding (Allsopp et al., 2007). This Matrix is relevant to this study in two major delineations; first, it defines and authenticates technology integration as the key dependent variable under study at the selected public universities and; second, it defines the processes involved in the integration and the extent to which students' perceptions, attitudes and challenges are affecting the adoption and adaptation of the five learning domains (entry, adoption, adaptation, infusion, transformation) in the process of infusing technology into the curriculum.

The Technology Acceptance Model (TAM) developed by Davis (1989), is an adaptation of the Theory of Reasoned Action (TRA) to the field of Information systems discussed by Venkatesh, Morris, Davis, & Davis (2003). The main objective of the TAM is to express the need for an individual to accept and adjust to new technological innovations and make use of it easily. However, the TAM's core concept is focused on users' motivation to assess their attitudes and perceptions towards the use of information systems. Due to the TAM's accuracy in forecasting the intention to adopt and use information technology, it has been tested, validated, and expanded throughout time (Liu 2010; Mohammadi 2015; Al-Azawei et al., 2017). According to Khodabandelou et al., (2016), students who use technology to excessively interact with their environment (via games, social media, etc.) are distracted and perform worse in class because of it. Within the context of the technology distraction challenge, the question raised is: how do the acceptance and use of these technologies facilitate or inhibit the integration of technology in schools? The importance of the TAM to this study is that students need to accept and adjust to the use of learning technologies as they pursue academic programmes. In the process, they face a myriad of challenges which impede their academic performance. Therefore, we can ask questions such as, what is the correlation between the challenges of students and their acceptance and adjustment to the use of technology? To what extent do the challenges affect the students' acceptance to use technology and adapt to new technologies?

The theory and practice of online learning (TOL) introduced by Anderson (2004), offered a paradigm of e-learning. Anderson proposed that three main types of online learning models should be considered: Collaborative, Community-of-Inquiry, and Community-of-Learning. Additionally, the model identified the two main human actors; learners and teachers, as well as how they interact with one another and the content. Interactivity is a major construct and striking characteristic of a web-based learning environment (Chou, 2003; Vrasidas, 2000). In the instructional context, interactivity refers to sustained, two-way communication between students and an instructor. Although learners can interact directly and impulsively with any content they come across in a variety of formats, particularly on the Web, many choose to have their education sequenced, directed, and credentialed with the help of a teacher in a formal education system. This interaction can take place within a community of inquiry, using a variety of Internet-based synchronous and asynchronous interactions (video, audio, computer conferencing, chats, or virtual world) within an interface known as the Learning Management System (LMS). According to van Dijk (2006), interacting with and through these media, the superior type of enacting learning is *simulated*, not equalled. Fox (2018), on the other hand, stated that the rise in technological distraction in classrooms was concerning. Even though using technology in a learning environment helps impart knowledge to students, the learners are exposed to the most recent technology, which has many

opportunities for misuse. Fox (2018) also pointed out that the use of digital learning tools, which has improved many students' academic performance, is morphing into an addiction trap. All these according to Fox (2018) are worrying decision-makers and educators. It is worthy to examine and understand how these challenges are linked to students' acceptance, interactivity, and use of the LMS within the context of technology integration in public universities. These make the theory of online learning relevant to this study because it serves as the underpinning theory for Interactivity (INT) and Learning Management Systems (LMS) which form part of the three mediating variables under study. A theoretical framework for this study is, therefore, presented in Figure 1 below.

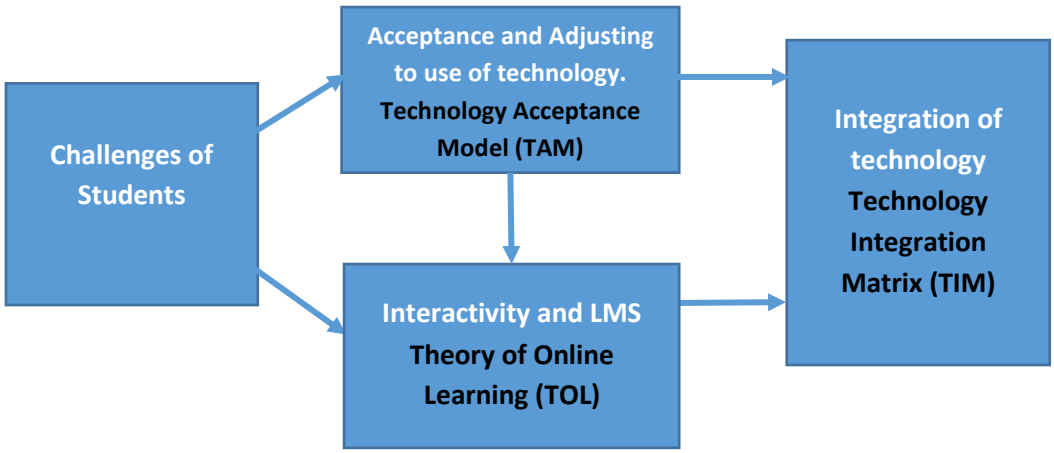

Figure 1*:* Theoretical Framework based on the TIM, TAM and TOL theories

Previous studies in Ghana have to some extent discussed the impact of challenges on the incorporation of technology in academic programs in Ghanaian public universities. This research sought to fill this knowledge gap to comprehend the impact of students' acceptance and adaptation, interactivity and use of the LMS, on technology integration. It is against this knowledge gap that the authors of this study formulated and tested the following hypotheses to serve as the main constructs for developing a conceptual framework.

HYPOTHESES FOR THE STUDY

Challenges of Students (CS)

The Challenges of Students is formulated as the exogenous variable based on the work of Mercader (2020), Boison (2019), Obiri-Yeboah et al., (2013) and Johnson et al., (2016). As such, this study sought to provide additional insight into the influence of Acceptance and Adjustment, Interactivity and LMS usage within the context of the Challenges of Students (CS) and Integration of Technology (IG) necessitating the question posed in hypotheses 1 to 4 below: 'To what extent do the Challenges of Students affect or impact the integration of technology through the lens of the AA, INT and LMS usage?'

H1: Challenges of Students (CS) have a significant impact on the Integration of Technology (IG).
H2: Challenges of Students (CS) have a significant impact on Acceptance and Adjustment (AA) to use technology.
H3: Challenges of Students (CS) have a significant effect on Interactivity (INT).
H4: Challenges of Students (CS) have a significant effect on Learning Management Systems (LMS) usage.

Learning Management Systems (LMS) usage

Learning Management System usage in this study is defined as an interactive learning environment embedded with learning technologies that facilitate inter/intra-action, cooperation, training, communication, and exchanging information among students (Dias & Diniz, 2014), and the effect of usage on the integration of technology. LMS usage is formulated as a construct based on the work of Anderson (2004); Claar et al., (2014); and Dias & Diniz (2014). As such, this study sought to provide additional insight into the influence of LMS usage within the context of AS and IG necessitating the question posed in hypotheses 7 and 8 below: 'To what extent does LMS usage mediate the linkage between CS and IG?'

H7: Learning Management Systems (LMS) usage has a significant positive impact on the Integration of Technology (IG).
H8: Learning Management Systems (LMS) usage significantly mediates the relationship between the Challenges of Students (CS) and Integration of Technology (IG).

Interactivity (INT)

Interactivity in this study refers to sustained, two-way communication between students and an instructor. A technology-based interactive learning environment incorporates four types of interaction: learner–content, learner–instructor, learner-learner, and learner–interface (Chou, 2003). Interactivity is formulated as a hypothetical construct based on the work of Anderson (2004); Liaw & Huang (2000); Chou (2003); and Vrasidas (2000). Although studies in interactivity have examined two-way communication between students and an instructor there is the need to provide additional insight on the mediating effect hence the question posed in hypotheses 6 and 9 below: To what extent does Interactivity mediate the linkage between CS and IG?

H6: Interactivity (INT) has a significant positive effect on the Integration of Technology (IG).
H9: Interactivity (INT) significantly mediates the relationship between the Challenges of Students (CS) and the Integration of Technology (IG).

Acceptance and Adjustment to technology (AA)

Students accepting and adjusting to the introduction of new learning technologies and adopting upgraded versions is dependent on whether they perceive that technology to be useful and easy to use. Acceptance and Adjustment to the use of technology is formulated as a hypothetical construct based on the work of Almahasees et al., (2021); Teo & Zhou (2014); Lai et al., (2012); Tagoe (2012); and Venkatesh et al., (2003). This study builds on and contributes to earlier work in acceptance by formulating and examining the following mediator-oriented hypotheses:

H5: Acceptance and Adjustment (AA) to use technology have a significant positive impact on the Integration of Technology (IG).
H10: Acceptance and Adjustment (AA) to use technology significantly mediates the relationship between the Challenges of Students (CS) and Integration of technology (IG).

Integration of Technology (IG)

In this study Integration of Technology refers to the use of digital tools and technologically based procedures for routine duties, employment, and educational administration. After making technology accessible and available, the next step is to integrate it. It is a goal-in-process, not an end state. (NCES, 2002)

METHODOLOGY

The conceptual model of this study is shown in Figure 2 below. The Technology Integration Matrix (TIM) presents five learning domains and corresponding levels of integration that determine the depth of technology Integration in HEIs. In a study conducted by Gyau & Gyan (2022), it was discovered that the method of technology integration that is predominantly being used by public universities is the Technology Integration Matrix (TIM) and the level of integration is currently at the 'Adaptation level' of the TIM. It is against this background that the TIM became the base model and most ideal definition for Integration of Technology (IG) which is also better positioned as the dependent variable for the study. The Challenges of Students (CS) is the exogenous variable being investigated and its impact on the integration of technology in the universities under study. Our proposed conceptual framework, therefore, attempts to investigate the relationship between the two key variables; Integration of technology (IG) and Challenges of Students (CS), mediated by the role of students' "Acceptance and Adjustment (AA)" to use technology, "Interactivity (INT)," and "Learning Management Systems (LMS) usage". Figure 2 below illustrates the relationship between the variables. Direct paths are represented by darker lines and indirect paths are indicated by dotted lines.

CONCEPTUAL FRAMEWORK

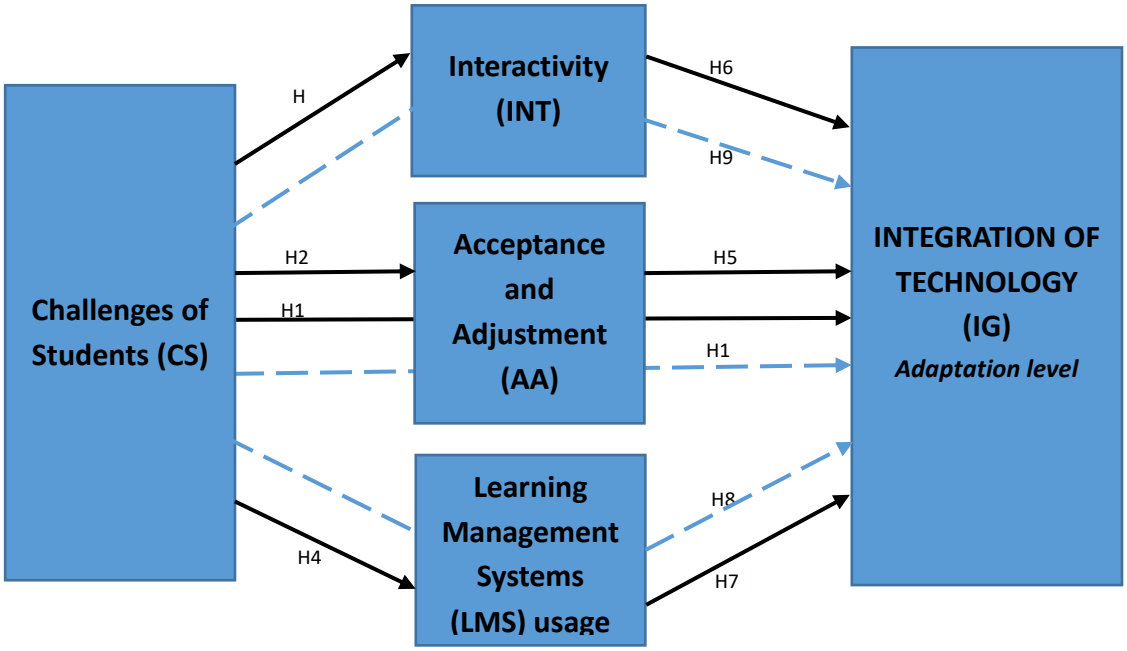

Figure 2: Proposed Conceptual Framework indicating the relationship between CS, AA, INT, LMS and the IG. (Source: Researcher, 2022

A quantitative approach was used to enable an objective measurement of the variables for this study and further examine the relationship between them numerically and statistically. Primary data was collected through questionnaires from students across six Public Universities in the country. The research philosophy was based on a Positivist and Constructivist paradigm and therefore a quantitative approach was employed (Creswell & Creswell, 2018). The research approach represents deductive reasoning through sophisticated statistical tests.

Sampling techniques

The sampling techniques used were purposive sampling, quota sampling and convenience sampling based on knowledge of the subjects under study. According to the Ghana Tertiary Education Commission (GTEC), there are 16 public universities in Ghana. The population for this study, therefore, considered sixteen (16) public universities (GTEC 2021). However, a purposive and convenient sample of six (6) public universities was selected from the Ashanti, Greater Accra and Northern regions for this study respectively. They were selected purposively, based on their status and rank in the adoption and integration of technology into mainstream university education. The overall intent was to identify HEIs which have attained a considerable or reasonable amount of penetration in their integration process, especially after the impact of the COVID-19 pandemic, a situation which forced all HEIs to integrate technology or improve the level of integration. The study, therefore, focused on the public institutions which were known to be conventional universities that had to adopt the dual-mode or blended mode of teaching and learning to ensure some level of integration of technology.

Quota sampling was used to select students based on particular attributes so that the sample size would not be different from the population. Whilst convenience sampling was used to select the individual students. A quota of 300 students was allocated to each of the selected universities (UG, UCC, UEW, UDS, UPSA and KNUST) irrespective of their large sizes. In addition, level 400 students were purposively selected based on their rank as final-year students and their experience in the technology integration process; having adopted and engaged various learning technologies for various academic activities over their 4-year tenure, pursuing various programmes. According to Taherdoost (2016), quota sampling is a non-probability sampling strategy in which participants are selected based on certain traits or criteria determined by the researchers. Next, based on the proportions of the subgroups (level 400 students) necessary for the final sample, the researchers allocated 300 units to solicit from the level 400 students and conduct the survey. Quota sampling was the best method for this study since it allowed the researchers to select students proportionally from all the universities. A specific number of questionnaires were distributed proportionally with the help of the faculties, to encourage completion of the questionnaires. The process made it possible for a representative sample of universities to take part in the study. Students were selected using quota sampling and convenient sampling and snowball methods were used to facilitate data collection.

However, the sample size was based on the criteria of Gay, Mills & Airasian (2009) who recommended that for a population of 5000 or more, a sample size of 400 is adequate. Factually, this sample size was not practicable for the researchers, because it did not conform to the resources available to the researchers, and it posed a huge financial burden. By using quota sampling, the researchers were able to target 300 students drawn from each of the 6 universities, for a total sample of 1800 students.

Data Collection Methods

By best practices, quantitative studies of this nature, are best conducted as a survey, deploying questionnaires as the ideal instrument (Creswell, 2008). A structured questionnaire with specific scales of measurement, drawn from validated instruments from Kumar & Daniel (2016) for attitudes, was modified for this research. Validity and reliability of the instrument were achieved by pre-testing and piloting the instrument. Six experts in the Educational and Instructional technology field scrutinised the instrument, therefore, subjecting the structured questionnaire to intense screening which led to the validation and invalidation of some of the questions. Pre-testing was further conducted with a cross-section of students from a sister university, to test the validity and reliability of the questions and refine some questions; to avoid respondent biases and researcher

biases. Scales of measurement in the questionnaire consisted of definite/close-ended statements as options in a 5-point Likert scale, where (1) = Strongly Disagree and (5) = Strongly Agree.

A total of 1800 students were targeted and contacted to participate in the survey and complete the questionnaire. After thorough screening of the completed questionnaires, a total of 100 were rejected due to inadequacies and incomplete answers. Eventually, a total of 1704 questionnaires were considered appropriate for data analyses, yielding a 94% response rate.

Data Analyses

Each item in the scales of measurement, representing the various constructs was first coded using Microsoft Excel Software and advanced using PLS-SEM for statistical analyses. This study adopted linear regression analyses and the Partial Least Square–Structural Equation Modelling (PLS-SEM) statistical tool, was ideal because SEM performs more robust and reliable statistical analyses for multiple latent constructs. Considering the proposed conceptual framework and hypotheses of this study, a structural model was formulated to guide the various tests relevant to the study.

RESULTS AND ANALYSES

The main objective that this study sought to achieve was to examine the impact of challenges of students on the integration of technology in academic programmes in the selected public universities. To address this objective, the students were asked to respond to pertinent questions. The data gathered from the respondents of the study were tested by the hypothesis drawn from the conceptual framework. This section presents the categorised results emerging from the analysis of the data.

Demographic Analyses of Quantitative Data

The demographic profile of students is shown in Table 1 below:

Table 1*: Demographic Profile of Students sampled from the six universities*

Variable	**Descriptive**	**N**	**(%)**
Gender	Male	839	49.6
	Female	861	50.0
AGE	18-25	1347	80.1
	26-35	329	18.2
	36-45	25	1.32
	46-55	2	0.11
Regional Distribution	Greater Accra Region	2	35.3
	Central Region	2	35.3
	Ashanti Region	1	17.6
	Northern Region	1	11.8

(Source: Field data, 2022)

Challenges that confront students in the technology integration process were solicited and itemized as indicated in Table 2. The results indicate the frequencies and percentages from the six universities under study.

***Table 2**: Challenges of Students*

	Challenges of Students	**Frequency**	**%**
CS1	Lack of Devices and Cost involved	525	30.8%
CS2	Network and Connectivity	230	13.4%
CS3	LMS and Technology know-how	200	11.7%
CS4	Lack of Technical Support	150	8.8%
CS5	Lack of Power Supply	150	8.8%
CS6	Lack of ICT Skills	140	8.21%
CS7	Lack of IT Infrastructure	100	5.8%
CS8	Lack of Data bundles	100	5.8%
CS9	Lack of Training	45	2.6%
CS10	COVID-19 and deploying the technology	44	2.5%
CS11	Quality of data bundles	20	1.1%
	Total	**1704**	**100.00%**

(Source: Field data, 2022)

Data Analysis

According to the standards set forth by Fornell & Larcker (1981), an exploratory analysis such as scale reliability, convergent and discriminant validity, and other factors must be evaluated while measuring the data. To identify the multi-collinearity among the variables, the study first used a preliminary test for the common method bias. The result of Variance inflation factors (VIF) as shown in Table 3 below indicated variations less than 3.3 as recommended by Kock (2015). Secondly, the study examined the convergent validity, discriminant validity and reliability of the structural model by adopting the criterion by Hair et al., (2021). Convergent validity is the degree to which multiple attempts to measure the same concept agree. When the AVE value is greater than or equal to 0.50 convergent validity is established, (Fornell & Larcker, 1981).

Convergent validity for this study was achieved with all the variables tested, except LMS usage, which recorded a value (0.441) a little lower than the 0.50 threshold. Discriminant validity is established when the square root of AVE for a construct is greater than its correlation with all other constructs (Fornell & Larcker, 1981)**.** Reliability is the extent to which a measuring instrument is stable and consistent. A threshold of 0.70 or above is recommended (Hair et al., 2011). The reliability of the data was tested using the PLS-SEM Crombach Alpha statistical instrument to determine the reliability coefficient of the data collected and analyzed. According to Ghozali (2012) and Awang (2014) the threshold for factor loadings should be 0.6 or higher. Reliability for this study was achieved with all the variables tested. The data in Table 3 below indicates the results for Confirmatory Factor Analysis, Cronbach Alpha, AVE, Construct Reliability and VIF.

***Table 3**: Exploratory analysis result and VIF*

Construct	Indicator	VIF	Loading	AVE	CR	(α)	R^2
Challenges of Students (CS)	CS1	1.960	0.692	0.527	0.924	0.910	
	CS2	2.322	0.702				
	CS3	2.102	0.736				
Acceptance & Adjustment (AA)	AA1	1.947	0.764	0.573	0.889	0.849	**0.575**
	AA2	2.448	0.815				
	AA3	2.607	0.842				
Interactivity (INT)	INT1	1.914	0.752	0.587	0.895	0.86	**0.310**
	INT2	1.988	0.775				
	INT3	2.226	0.789				
Learning Management Systems (LMS)	LMS1	1.549	0.775	0.441	0.814	0.753	**0.288**
	LMS2	1.716	0.792				
	LMS3	1.737	0.822				
Integration of Technology (IG) *(Itemized with the TIM variables)*	ENTRY	1.841	0.778	0.613	0.888	0.842	**0.294**
	ADOPT	2.281	0.829				
	ADAPT	1.959	0.816				
	INFUSION	1.725	0.735				
	TRANS	1.699	0.754				

(Source: Field data, 2022)

Discriminant validity is established when the square root of AVE for a construct is greater than its correlation with all other constructs (Fornell & Larcker, 1981). The values for discriminant validity in the study which were all less than 1, are shown in Table 4 below. Bold values indicate the square root of AVE.

***Table 4**: Discriminant Validity*

	AA	CS	IG	IN	LMS
AA	**0.757**				
CS	0.759	**0.726**			
IG	0.468	0.49	**0.783**		
INT	0.546	0.557	0.226	**0.766**	
LMS	0.524	0.537	0.412	0.363	**0.664**

(Source: Field data, 2022)

Measurement of Model fit

Based on the 0.10 cutoff (Falk & Miller, 1992), the structural model in this study obtained acceptable R^2 values for the three mediating variables and the dependent variable under study as shown in Table 3 above. The anslysis reveals an R^2 value of 0.575 for Acceptance and Adjustment to Technology, and 0.294 for Integration of Technology. Interactivity attained an R^2 value of 0.310 and the Learning Management System (LMS) usage attained an R^2 value of 0.288 as indicated in Table 3. The relationship coefficients are illustrated in the structural model in Figure 3 below.

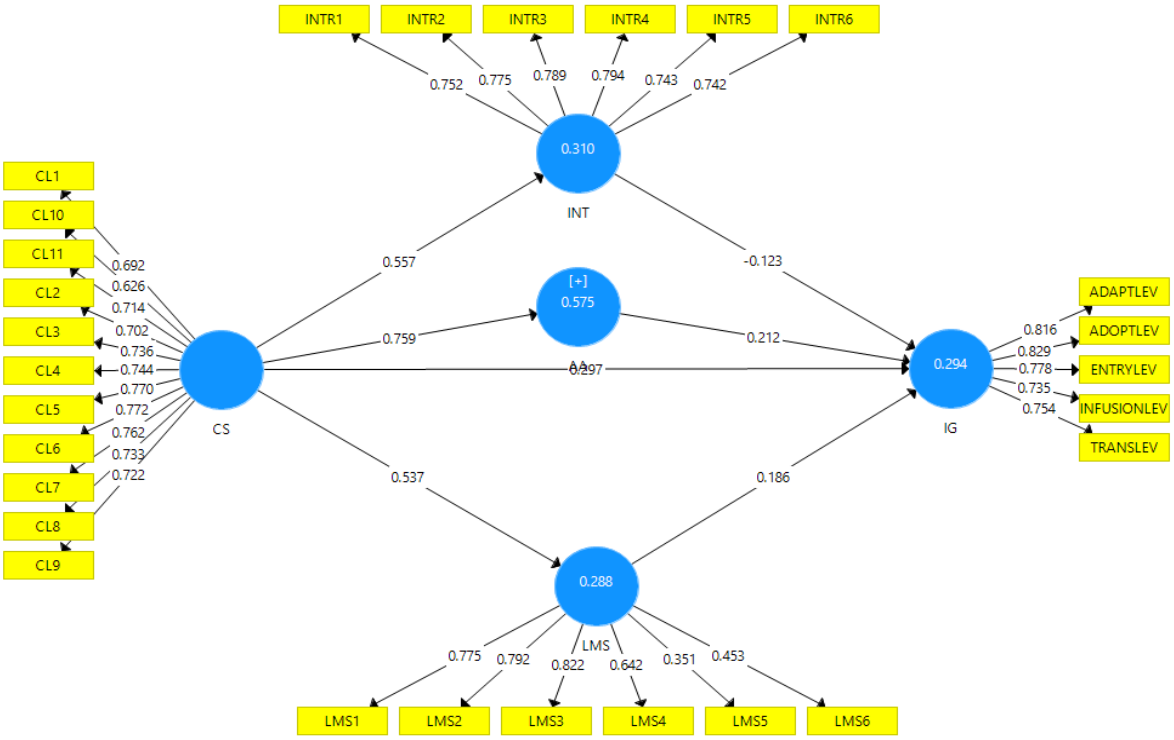

Figure 3: Structural model indicating the regression analyses and relationship coefficients between all variables (Source: Researcher, 2022)

Mediation Analyses of Learning Management Systems (LMS), Interactivity (INT), Acceptance and Adjustment (AA)

Mediation analyses were performed to assess the mediating role of Learning Management Systems (LMS) usage on the linkage between Challenges of Students (CS) and Integration of Technology (IG). The results indicate that the indirect effect of CS on IG was significant (H8: β = 0.490, t =11.851, p = 0.000). Hypothesis H8 was therefore supported as shown in Table 6 below. This indicates that the relationship between CS and IG is fully mediated by LMS usage. Meanwhile, the results, in Table 5, revealed that the direct effect of (LMS) usage on (IG) is also significant (H7: β = 0.211, t = 2.087, p = 0.037). Hypothesis H7 was therefore supported.

Table 5*: Direct effects of the relationship between CS and AA on IG.*

Hypotheses	**Constructs**	**Coefficient** (β)	**Standard Dev**	**T Statistics**	**P Value**	**Outcome**
H1	CS -> IG	0.490	0.041	11.851	0.000**	Supported
H2	CS -> AA	0.759	0.029	26.062	0.000**	Supported
H3	CS -> INT	0.557	0.047	11.821	0.000**	Supported
H4	CS -> LMS	0.537	0.041	13.002	0.000**	Supported
H5	AA-> IG	0.187	0.061	3.136	0.002**	Supported
H6	INT-> IG	-0.125	0.066	1.900	0.058	Not supported
H7	LMS -> IG	0.211	0.10	2.087	0.037**	Supported

(Source: Field data, 2022)

Pursuant to these results, mediation analyses were also performed to assess the mediating role of Interactivity (INT) on the linkage between CS and IG and the indirect effect of CS on IG through the INT was found to be not significant (H9: β =-0.069, t =1.826, p=0.068). Hypothesis H9 was therefore not-supported as indicated in Table 6 below. This indicates that Interactivity does not have any significant impact on the relationship between CS and IG. Meanwhile, the results, in Table 5, revealed that the direct effect of (INT) on (IG) is also not-significant (H6: β = -0.125, t = 1.900, p = 0.058). Hypothesis H6 was therefore not supported.

Table 6: *The mediating effect of LMS, INT and AA on the correlation between Challenges of Students (CS) and Integration of Technology (IG)*

Hypotheses	**Constructs**	**Coefficient** (β)	**Standard Dev**	**T Statistics**	**P Value**	**Outcome**
H8	CS -> LMS -> IG	0.101	0.032	3.165	0.002**	Supported
H9	CS -> INT -> IG	-0.069	0.038	1.826	0.068	Not Supported
H10	CS -> AA -> IG	0.160	0.076	2.095	0.037**	Supported

Finally, mediation analyses were performed to assess the mediating role of Acceptance and Adjustment (AA) to technology, on the correlation between Challenges of Students and Integration of Technology (IG). The indirect effect of CS on IG, through the AA, was found to be significant (H10: β = 0.160, t = 2.095, p = 0.037*). Hypothesis H10 was therefore supported as indicated in Table 6. Meanwhile, Students' Acceptance and Adjustment to Technology had a direct significant impact on the Integration of Technology (H5: β = 0.187, t = 3.136, p = 0.002*). Therefore, hypothesis H5 was supported as indicated in Table 5. This shows that the Challenges of Students directly impact on Integration of Technology and the linkage is fully mediated by students' acceptance and adjustment to the use of technology. Therefore, Acceptance and Adjustment (AA) to use technology by students, is a strong predictor of Integration of Technology.

More intuitively, the Challenges of Students also have a direct positive effect on Students' Acceptance and Adjustment to patronize technology as indicated in Table 5 (H2: β = 0.759, t = 26.062, p = 0.000). Hypothesis H2 is therefore supported. This result indicates that the Challenges of Sudents in the public universities in Ghana are a strong predictor of students' acceptance and adjustment to the use of technology in their academic pursuits. Similarly, the Challenges of Students have a direct positive effect on Interactivity (INT) in the integration process as indicated in Table 5 (H3: β = 0.557, t = 11.821, p = 0.000). Hypothesis H3 is therefore supported. Finally, the Challenges of Students also had a direct positive effect on the use of Learning Management Systems (LMS) in the integration process, as indicated in Table 5 (H4: β = 0.537, t = 13.002, p = 0.000). Hypothesis H4 is therefore supported. The Challenges of Students is a strong predictor of students' patronage of the LMS in the entire technology integration mix in the public universities in Ghana.

Proposed Conceptual Framework

The authors of this article, in a quest to determine the variables that will be necessary for developing a new conceptual framework, considered and tested the relationship between the independent variables (CS) and the dependent variable (IG), vis-a-vis the mediating variables (AA, INT, LMS). Based on the research conducted and the hypothesis tested through regression analyses, we propose a Conceptual Framework underpinned by variables of the Technology Integration Matrix (TIM) and the ten hypotheses that provide insight into the path analyses. Each path is represented by the hypotheses tested and labelled (H1-H10). The mediating effects of AA, INT, and LMS on the linkage between Challenges of Students (CS) and Integration of Technology (IG) are shown in

Figure 4 below. The darker lines are paths that indicate direct effects whilst the dotted lines indicate mediating effects (indirect).

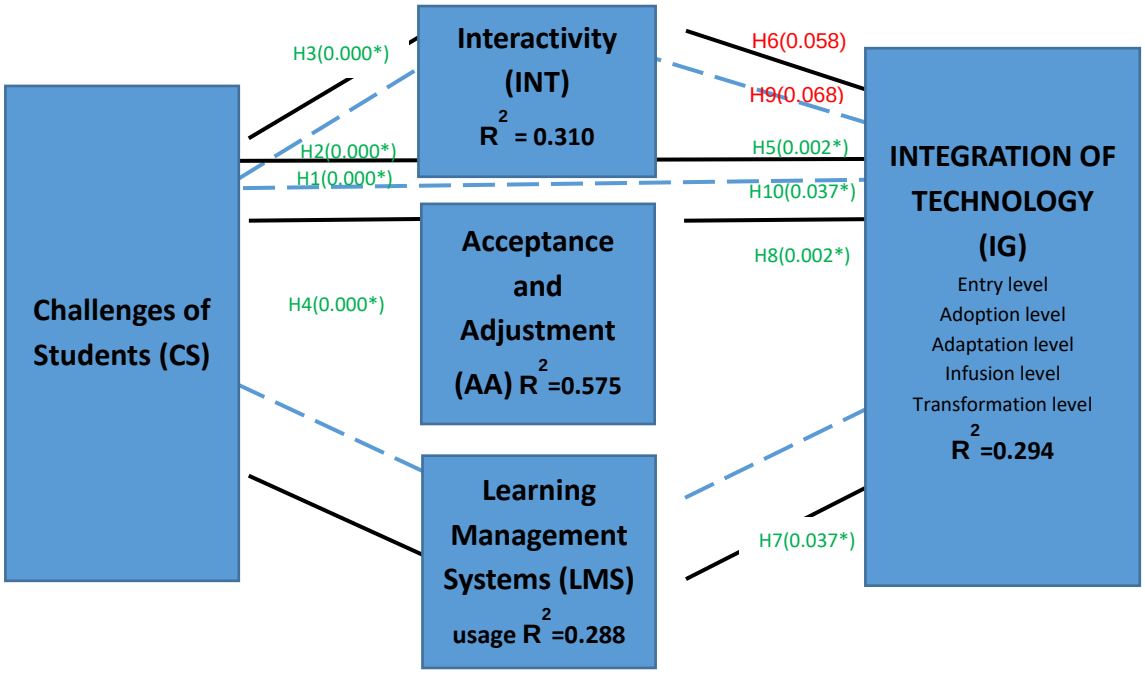

Figure 4: Proposed Conceptual framework (Source: Researcher, 2022)

FINDINGS AND DISCUSSION

The findings indicate that 57.5% variation in Students' Acceptance and Adjustment to technology can be attributed to the Challenges of Students. As indicated in Table 3, 29.4% variation in Integration of technology (IG) can be attributed to the Challenges of Students. Moreover, 31.0% variation in Interactivity (INT) can also be attributed to the Challenges of Students. Finally, 28.8% variation in the use of Learning Management Systems (LMS), can also be attributed to the Challenges of Students in the public universities in Ghana. Although the relationship co-efficient of the IG, INT and LMS are quite low, they are still above the threshold, and there is every indication, from the results of the regression analyses, that Students' Acceptance and Adjustment (AA) to the use of technology has a strong positive impact on the integration of technology; whilst LMS usage and INT have a low impact on the integration of technology in higher education in Ghana.

Challenges of Students, in this study, has been found to have a direct and significant impact on the Integration of technology into academic programmes in Ghanaian public universities. More intuitively, students' acceptance and adjustment to the use of technology and patronage of the Learning Management Systems (LMS), are strong predictors of integration because they significantly mediate the relationship between the Challenges of Students (CS) and Integration of Technology (IG). This is indicative of the fact that the Challenges of Students have both direct and indirect effects on the Integration of Technology. It is imperative to note in this discourse that although the study outcomes of many researchers (Aldowah et al., 2015; Pelgrum 2001; Ertmer 1999; Herzig 2004; Bingimlas 2009), have revealed that there are numerous barriers to the

integration of ICT in higher educational institutions in different environments, these barriers, in the Ghanaian context have been found to impact integration directly and indirectly.

Underscoring the fact that students' Acceptance and Adjustment (AA) to use technology and Learning Management Systems (LMS) are significant positive mediators or predictors to the integration of technology, the authors of this article suggest that the challenges that confront students in Ghanaian public universities in recent times, have been mitigated to a very large extent, by the introduction of policies and policy directives during the COVID19 pandemic. This is demonstrated by the immediate solutions that management of the respective universities were forced to implement to ensure the successful completion of the academic years. The caveat is that many students were compelled to accept and adjust to the use of new learning technologies such as Zoom, MS Teams, Google Meet, Big Blue Button, and Social Media platforms, among others, to be able to continue, an already interrupted academic work, and complete successfully. This is more so in the case of final-year students who were in their final semester when COVID-19 struck. The new learning technologies were also embedded or integrated into the LMSs (MOODLE or SAKAI), which anchored and steered the key actors in the integration process, thereby facilitating their mandatory duties. The LMSs were accessible and effectively managed by IT Support staff and lecturers, and students likely became familiar with and confident to use the LMSs for continuous learning and academic achievement. There is, therefore, no doubt, that Students' Acceptance and Adjustment (AA) to use technology through the LMSs with all its embedded tools have proven to significantly mediate or impact the integration of technology in academic programmes over the period 2020-2022. This is in line with the theoretical contributions of Davis (1989) TAM theory, and the Theory of Online Learning by Anderson (2004) which emphasized the need for interactivity in the online learning eco-system and the need for platforms such as LMSs to facilitate synchronous and asynchronous interactions.

The authors of this article also found that the Learning Management Systems (LMS) used by students, significantly mediate the relationship between the Challenges confronting students and the Integration of Technology in the curriculum. Interactivity (INT), on the other hand, has an insignificant impact on the Integration of Technology (IG) and therefore the hypothesis was not supported. This is consistent with the theory of online learning by Anderson (2004) that learners can interact directly and spontaneously with any content they come across in a variety of formats, particularly on the Web. This interaction can take place within a community of inquiry, using a variety of Internet-based synchronous and asynchronous interactions within the Learning Management Systems (LMS). There is a strong interdependency between LMS usage and Interactivity. Increasingly, the LMS usage is proven to be that interface, where communities of inquiry are being created to facilitate teaching and learning and interactions between students and their instructors as well as peers. Such interactions through the LMSs became even more predominant with the introduction of video conferencing interfaces such as ZOOM, MS TEAMS, GOOGLE MEET, and Social Media platforms, which tremendously increased the interactivity between students and their lecturers and even other stakeholders in the integration chain.

In a study conducted by Gyau & Gyan (2022) a paradigm shift in the culture of students in recent times was noted. This shift was deduced from a qualitative study where policymakers asserted that students have in recent times, progressively resorted to the use of *search engines* and *WhatsApp* and *Facebook* group chats as the main publishing platforms for interactivity among peers and lecturers; a situation, which policymakers described as worrying. However, this may have accounted for why Interactivity had an insignificant impact on the Integration of Technology. As inherent as it may be, it is imperative to note that all Learning Management Systems rely on interactive elements and as much as some universities incorporated social media interactive tools, others have not. More so, students rarely used FORUM Discussion panels that have been embedded into the LMS, because they were not familiar with them before the COVID-19 pandemic, unless otherwise initiated by the instructors for the assignment, quizzes, and continuous

assessments. Students, therefore, resort more frequently to social media interaction tools and group chats that are accessible and quickly facilitate their usual interactions with peers and lecturers.

Limitations and future directions

We have provided quantitative data to report the challenges of students on the integration of technology; however, our findings should be considered in the scope of ad hoc or interim policy directions that compelled students to participate in the technology integration process for academic achievement in the post COVID-19 era, in the top public universities in Ghana. Future research should therefore look at the current or future policies that have been institutionalized for the integration of technology in public and private universities, and conduct the study based on provisions of the policy. Further, it is suggested to test the efficacy of the policy directions and its impact on the integration of technology among students, because as a limitation, this study did not consider the provisions of the ad hoc or interim policies that were put in place because of the onslaught of the pandemic.

CONCLUSION AND RECOMMENDATIONS

Underestimating the effects of the challenges that confront students in the state universities in Ghana in contemporary times, can be detrimental to the absolute infusion of technology in the curriculum. The finding that challenges confronting students in the processes of infusing technology have both direct and indirect significant impacts on the integration of technology is important. The mediating role of acceptance to use technology via the LMS and the significant positive impact of the LMS on the integration of technology is also an important finding. Previous studies mainly focused on the general challenges of students, but this study has extended the literature to examine the specific effects of students' challenges on the integration of technology in academic programmes in public universities, accentuating the mediating role of Acceptance, Adjustment and LMS usage on the Integration of Technology. This study fills the contextual gap in the literature by conducting a study in a developing country, Ghana, and against this backdrop, we make the following recommendations.

By policy implications, we recommend that policymakers and implementers in the state universities in Ghana should better understand that the challenges of students, though partially mitigated, have been proven to have direct and indirect impacts on the integration of technology in academic programmes. Additionally, they must also acknowledge that students' acceptance and adjustment to the use of technology through the LMSs have a significant positive effect on the infusion of technology. Therefore, policymakers must revise policy to increase and improve the institutional mechanisms and technical support systems that have been instituted and mandate the streamlining of students' academic activities to actively accept the learning technologies that have been implemented. Further, they should also ensure constant patronage of the various forms of LMS, in which the universities have invested heavily. This will encourage momentum for the Integration of technology in academic programmes.

Students' acceptance and adjustment to the use of technology as well as the LMS are key drivers for integration and have the potential to curtail the challenges which impede Integration, while stimulating interactivity among their peers and lecturers. Policymakers must therefore create the conditions that encourage students to use the LMS and quickly adapt to the use of new technologies that are integrated in the LMS if technology is to be fully integrated into academic programmes.

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