Teaching as a Service: An Exploration of Educational Framework for Technology driven teaching for Higher Education Institutions

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Abstract: This study examined Teaching as a Service and explored the educational framework for technology-driven teaching in Higher Education Institutions (HEI) in Uganda. This was done by looking at status of ICTs in terms of device ownership, internet utilization for instructional purposes, information technology adoption, Learning Management Systems (LMS) and Enterprise Resource Planning Systems (ERP), available resources, and capacity-building initiatives as signals for utilization of technologies for teaching. A deductive approach was used to select 30 individuals from public, private, and institutionally affiliated universities, organized into groups of ten who participated in the study. The first cohort contributed insights into the initial components of TaaS framework, which were iteratively refined until a stable framework emerged. Subsequently, an examination was conducted to ascertain the presence of these components within higher education institutions (HEIs). The investigation revealed that up to 80% of the respondents predominantly utilized ICTs individually or through institutional provisions. Access to ICT was primarily facilitated via personal laptops and smartphones, bolstered by robust infrastructure and widespread broadband connectivity within most institutions. Internet accessibility was pervasive across various campus locations, with most respondents engaging with online resources daily up to 90% of use time. The study revealed that HEI are in the initial phases of adopting technologies for teaching. Adapting TaaS framework can go a long way in helping HEIs to adopt technology effectively.

Keywords: Teaching as a Service (TaaS), Digital Transformation, higher education institutions (HEIs), e-learning, education technologies, education innovation, e-teaching.

1. Introduction

The rapid advancement in computing and vast coverage of Internet access is a key player in the development of diverse sectors of the economy. The biggest impact has been observed in health, banking, transport and education [1]. The true examination of whether education can adapt to the use of various technologies in teaching and learning occurred when the world was overwhelmed by Covid-19. This led to the disruption of traditional education systems requiring a swift transformation in teaching and learning processes. The designed in-person interactive learning quickly transcended into online education - a move that enabled the transfer of knowledge without being constrained by geographical barriers [2] [3].

Studies in [4] [5] evidenced the process of education transformation required careful preparation, design and determination of aims and objectives to drive effective teaching and

learning processes. Additionally, authors in [6] articulated that digital transformation process involves concepts of adequate strategic planning, trust building, critical thinking, integration of different stakeholders, collaboration and institution knowledge. These attributes in aforementioned studies were absent in many HEIs creating difficulty in swiftly adopting any other method of teaching during the hard times of Covid -19.

To achieve sustainable online education as a way of disseminating information, knowledge and resources bounded by geographical barriers, strategies of digital transformation must be adopted [7]. Nevertheless, the transition from traditional in-person education to virtual classes faces significant obstacles in developing countries. These obstacles primarily revolve around resistance to change from conventional teaching practices, inadequate infrastructure encompassing essential internet access, hardware, and software requirements for supporting online education, recurrent and often substantial costs associated with maintaining online educational initiatives, the absence of well-defined frameworks for addressing quality assurance, content development, data security, regulatory compliance, accreditation, limited resources, and academic proficiency [8],[9],[10].

Studies in [11] highlighted five hypothesis that prevent digital transformation in Higher Educational Institutions (HEIs). The rapid pace of technological change necessitates swift adaptation to remain relevant in the current era. The second hypothesis suggests that HEIs may be reluctant to embrace online education due to a resistance to change. This proposition finds support in the work of [3], which introduces the concept of a "new normal" in education, signifying a fundamental shift from traditional approaches. Additionally, it becomes evident that averse attitudes towards change may hinder the progress of academic institutions [12]. The third claim asserts that technology drivers are not evenly distributed among the user community, resulting in a digital divide that leads to disparities in the acquisition of current technologies within the educational sector. Furthermore, the fourth hypothesis suggests that the effective utilization and acceptance of information technologies for teaching necessitate a certain level of competence in skills and knowledge. This diverse skill set enables the proficient management and appropriate use of technology in the context of teaching and learning. Additionally, proficient management of these technologies may lead to curricular adjustments that will steer students toward competency-based learning. The final assertion underscores that achieving successful technological implementation demands well-considered financial commitment—this expedites the digital transformation process, encompassing infrastructure procurement, installation procedures, user training, and the recruitment of qualified personnel. To answer these assertions, a framework for planning, designing and implementing ICTs is required. This shall help consistent delivery of education as a service, and also ensure quality standards and benchmarks are adhered to.

Education institutions have continually invested in teaching technologies. However, this investment has been met with several specific challenges, including inadequate infrastructure, high cost of investments in technology, lack of a structured approach for content development, concerns over data security, and issues with regulatory compliance. We hypothesize that the rapid pace of technology change necessitates swift adaptation; furthermore, the uneven distribution of technology creates a digital divide, while technology proficiency remains crucial for effective teaching. We propose a comprehensive framework for planning, designing, and implementing Information and Communication Technologies (ICTs) in Higher Education Institutions (HEIs) to address these specific challenges and hypotheses.

Given this premise, this paper investigates the potential of the Teaching as a Service (TaaS) framework as a means to bridge the divide by fostering the integration of students, educators, and subject matter experts. This integration is aimed at ensuring the continuity of

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education in times of crisis, and in the post-pandemic landscape should another such event similar to Covid-19 occur in the future Thus, the rest of this paper is organized as follows, section 2 provides objectives. In section 3 methodology was presented, section 4 presents the technological description of TaaS, section 5 results and discussion, section 6 provides a conclusion and future work are drawn.

2. Objectives

The main objective of this study is to propose a framework for "Teaching as a Service" with the aim of ensuring the ongoing enhancement and sustainability of educational services. In pursuit of this goal, the study encompasses an evaluation of digital proficiency levels, an assessment of available ICT resources within these institutions, and an exploration of methods for integrating technology effectively. This research specifically seeks to achieve the following:
1. Evaluate the digital presence of infrastructure in HEIs. This is done by identifying required infrastructure, areas of training, and develop strategies for improving digital skills and competence.
2. Examine the accessibility and ownership of ICT services among educators to address issues related to Internet connectivity, and propose measures to ensure equitable access to digital resources for teaching.
3. Formulate a TaaS framework that shall help consistent delivery of education as a service ensuring quality standards and benchmarks

3. Methodology

We adopted a deductive approach for the development of the TaaS framework, employing an iterative process involving three snowballed clusters of ten (10) individuals each for three clusters drawn from 10 universities of the 40 prominent HEI in Uganda. In the context of this research, individuals with the following attributes within Higher Educational Institutions (HEIs) are regarded as experts: i) those proficient in integrating technology into teaching and learning, ii) specialists in instructional technology and content development processes, and iii) consultants with expertise in the administration of HEI business processes. These experts were drawn from the administration, academic departments and Information technology section of the institution involved in the study.

The first cluster, purposefully selected from a diverse range of Higher Education Institutions (HEIs), including public and private universities in Uganda. These included 5 private university, 4 public universities and Uganda technical college. The respondents in the first cluster were chosen purposely and independently of specific faculties and departments. These Individuals were engaged in consultations and interviews.

In the second cluster, 10 experts and an enhanced interview was employed to refine, and deepen the study's understanding of the TaaS framework's components. This refinement process reinforced efforts aimed at improving the initial model based on additional insights gathered from interviews with the second cluster of experts.

And lastly, a third cluster of 10 experts was drawn to validate and verify the framework's components. Simultaneously, we developed a tool to assess digital infrastructure presence, identify training needs, evaluate available ICT resources, and assess the level of technological integration within HEIs.

4. Technology Description

The rapid advancement in computing and widespread Internet access has significantly impacted various sectors of the economy, with notable effects on health, banking, transport, and education. The emergence of the COVID-19 pandemic forced a rapid shift from

traditional in-person education to online learning. While studies emphasize the importance of strategic planning, trust building, critical thinking, stakeholder collaboration, and institutional knowledge in the digital transformation of education, many Higher Educational Institutions (HEIs) face challenges in adopting online education. These challenges include lack of infrastructure, availability of contents, poor connectivity, quality assurance etc.

In this study we propose Teaching as a Service (TaaS) framework intended to distribute teaching resources in a bid to alienate challenges encountered by HEI in adopting information and communication technology. The proposed framework consists of eight (08) model dimensions to explain the use of information and communication technologies to enable Teaching as a Service at HEI. The model dimensions are: Infrastructure, Policy, Knowledge, Content, Quality Assurance, Data Analytics, Technical Support, and Cost.

First, the *Infrastructure model* which emphasizes that for any HEI to successfully adopt TaaS it must have well-positioned ICT infrastructure. Second, the *Policy model,* which is based on the fact that any HEI to well execute proper deliver of TaaS it must have a well-positioned policy. Third, the *Knowledge model* that declares that to properly deliver TaaS, the stakeholders (teachers, students, administrators etc.) must have the minimum required knowledge to use TaaS infrastructure. Fourth, the *Content model* that states proper teaching is directed by well-constructed certified content that fits the vision of education for the society. Fifth, the *Quality Assurance model* involves set procedures designed to ensure high quality, effective teaching as a service. Sixth, the Data *Analytics model*, whose purpose is enabling institutions to draw insights from activities in the institution. Seventh, the *Technical Support model* and lastly, the Cost *model* both of which are tied closely to the evaluation of the implementation, operational and maintenance costs.
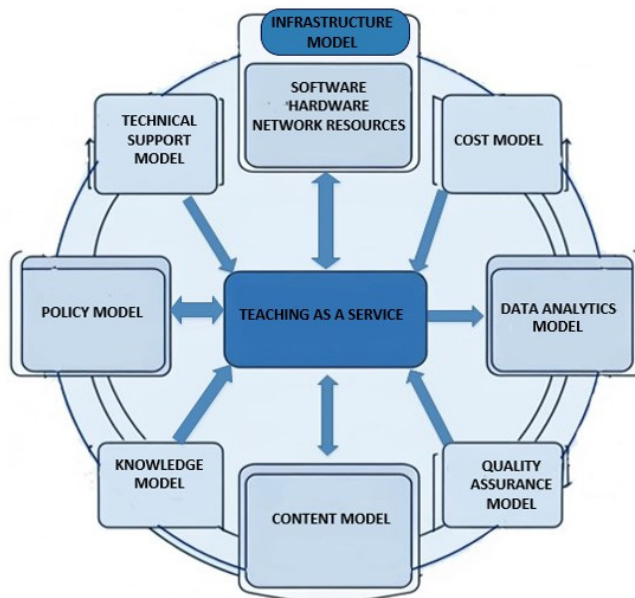
4.1 Components of TaaS framework

Figure 1: Teaching as service framework for HEI

Infrastructure Model
The infrastructure model underscores the critical importance of well-developed ICT infrastructure for the successful implementation of Teaching as a Service (TaaS) within Higher Education Institutions (HEIs). This infrastructure encompasses hardware, software, connectivity, and other related components that are essential for facilitating the seamless operation of TaaS in an educational setting. The infrastructure serves as the cornerstone of TaaS, enabling the creation and effective management of learning systems. Unfortunately,

the significance of infrastructure as an enabler of e-learning is often underestimated, leading to a lack of understanding regarding its role in supporting TaaS.

Establishing a robust infrastructure framework is pivotal, as it paves the way for instructors to effortlessly transmit course content to learners, thus aligning with the overarching goals of TaaS as a framework. This framework component is grounded in the belief that infrastructure lay the fundamental groundwork for TaaS and are rooted in the practical realities of the teaching world—which is increasingly embracing online learning as a primary teaching method across various educational levels. These finding are consistent with studies in [13]–[15] who explained the importance of ICT infrastructure in creating a robust teaching ecosystem in schools

Policy Model

For an institution to effectively carry out all aspects of Teaching as a Service (TaaS), it is imperative to have a well-defined and organized set of policies in place. These policies serve as the foundation upon which the institution can progress towards its goals of transitioning education to the "new normal" through the implementation of the Teaching as a Service framework (TaaS). These policies encompass various aspects, including but not limited to e-admission procedures, e-instructional methods and delivery, e-examination protocols, and adoption of any emerging technologies. They provide the necessary guidelines and directives for individuals to execute diverse tasks associated with the delivery of teaching as a service in an educational environment. Incidentally, national policies do exist but are not adapted at HEI, these finding concede with those in [16], [17].

Knowledge model

The knowledge model is responsible for managing knowledge. Its purpose is to organise content in high quality education material suited for dissemination for particular groups of learners. This model is complemented by the data analytics and content model. This model is responsible for search and retrieval components, personalization, collaboration features and integrations with other learning management systems. It is generally agreed by respondents that HEI in Uganda have no consistent way of organising knowledge according to the learner differences. We hope on implementation of knowledge models the learner differences can be bridged by looking at particular characteristics of the learns at higher education. This component shall provide insights in educational analytics at HEI as observed in studies [18][19].

Content model

The content model contains systems that enable creation, organising, management and delivery of education content. This model is at the centre of learning process because it ensures that content is effectively produced, stored, accessed and utilized well across learning groups with differing learning needs. Content model defines the core function of TaaS. The content dimension of TaaS involves; content creation and development, organisation, storage and repository, access control and permission, content quality assurance, content improvement and versioning among others. Studies in [20], [21] offer comparable insights into content models.

Quality Assurance model

This involves set procedures designed to ensure high quality, effective teaching as a service. This model is relevant for maintenance of the integrity of TaaS learning experience and meeting the expectation of both instructors and students. Most importantly it involves quality standards and benchmarks, compliances, pedagogical innovation, instruction deigns and curriculum and content quality. Quality assurance model in TaaS serves to enhance the

overall educational experience, maintain high standards, and drive continuous improvement in the delivery of teaching services. It promotes student success, ensures instructor satisfaction, and helps educational institutions adapt to evolving teaching and learning paradigms [22], [23].

Data analytics model
This plays a critical role of enabling institutions to draw insights from activities in the institution. In particular, the model fosters data driven decision making, and enhances learning experiences. This also consists of data collection, data process-tidying, data visualization, and modelling. The modelling component involves different analytic activities that include descriptive analytics, predictive analytics, prescriptive analytics, learning analytics, and feedback and assessment analytics. This model is responsible for empowering organisations with informed decisions, improve learning experiences, and boost the general outcome of education system [18], [19].

Cost model
The cost model involves structural activities that enable estimating, planning, and managing the cost associated with implementation, operation and maintenance of the TaaS systems. The model is the core for budgeting and controlling expenses. The module includes initial cost implantation, operational cost, infrastructural cost, maintenance and upgrade costs, return over investment, and cost benefit analysis of the TaaS systems. Cost models for ICT adoption can be viewed from others studies such as in [21], [24].

Technical support model
This is a critical component of TaaS that is designed to provide assistance, troubleshoot technical issues, ensure smooth operations, and usage of TaaS. Its purpose is mainly to deliver effective, uninterruptable teaching, and learning services. This module includes helpdesk services—handles inquiries, receives problem reports, and stop point for the users of the TaaS systems. Second, it is responsible for bridging the gap between the technical team, and the users requiring the component is always available. The team at the technical support level contains the communication officers, technical expertise, user trainers, and remote support [25].

4.2 Business Benefits

We expect TaaS to provide numerous benefits to institutions of higher learning institutions. These benefits should see the institutions improve their efficiency, effectiveness and competitive advantage. Particularly, institutions can handle multitudes of students with different education needs. Second, this framework when adopted can encourage lifelong learning amidst reduced administrative cost as well as efficient resource utilization. In addition, TaaS enables global reach of students and lecturer. In general, TaaS allows to better serve the student and adopt evolving workforce demand of societies.

5 Results and discussion

A preliminary investigation was carried out in various higher education institutions in Uganda with the aim of evaluating the provision of Teaching as a Service (TaaS). Aspects such as ownership of devices, the utilization of the Internet for teaching purposes, the evaluation of information technology use, the presence of Learning Management Systems (LMS) and Enterprise Resource Planning Systems (ERPS), the variety of resources available, and the efforts made in capacity building were examined.

The investigation revealed that respondents primarily utilize Information and Communication Technology (ICT) resources, which are often provided either individually

or by the institutions they are affiliated with. Access to ICT is predominantly facilitated through individual laptops and smartphones. These findings are in line with [26] who noted laptops and smartphones as devices of choice for respondents. While the majority of the institutions 80% offer desktop computers and laptops, some also provide Internet access in Higher Education Institutions (HEIs) through smartphones, hotspots, and portable MI-FIs devices. Furthermore, 80% of the institutions have broadband connections in place to support relevant digital needs. Findings also evidenced availability of Internet access across different locations within these institutions—classrooms (70%), libraries (90%), hostels (60%), laboratories (70%), reception and lounges (40%), seminar halls (60%), student common rooms (40%), and open areas (40%).

It was also observed that 80% of respondents use the Internet daily, while the remaining participants access it on alternate days. 10% indicated that they do not use the Internet at all. However, these findings differ from the Adarkwah et al. [27] study on the use of ICT in post Covid-19 period in Ghana where they reported inadequate infrastructure as a key barrier to ICT integration in HEI. This view was further supported by a study carried out in Tanzania which identified that over 65% of teachers lacked access to Computer resources whilst 73% of the teachers noted that they experienced low internet speeds which affected their pedagogical processes[26], [28]. Unlike Ghana, Tanzania and other African countries, Higher education institutions in Uganda have found funding through the Ministry of education, Ministry of ICT, Ministry of finance, in addition to educational loans from world bank, and the Islamic Development Bank.

Upon exploring the utilization of Information and Communication Technologies (ICTs) in Higher Education Institutions (HEIs), the findings reveal that computer applications are commonly employed for teaching purposes. A majority of respondents exhibited expertise in using word processors, PowerPoint, and email. Advanced skills were observed in the use of spreadsheet software and search engines. Conversely, basic to intermediate proficiency was evident in multimedia authoring, database management systems, graphic editing, digital authoring, and the utilization of artificial intelligence (AI) tools. Notably, a limited number of respondents demonstrated competence in web 2.0 tools, website design and development, and the creation of simulation tools for teaching. All this is in line with Batra and Kumar [26] who noted that teachers especially in science field must possess significant knowledge in ICT utilization (software) for improvement of pedagogical delivery and practice.

On the same note, [29], [30] evaluated the impact of multimedia aided content on learners' academic achievement and it was established that learners who interacted with multimedia aided content performed better than their counterparts who used normal lecture content. Thus, teachers should be trained in multimedia content creation, integration and delivery. Furthermore, it was observed that institutions had made investments in Learning Management Systems (LMS) or Enterprise Resource Planning Systems (ERPS). However, the usability of these systems presents challenges, particularly in HEIs operating under government arrangements where student associations have mounted pressure on government to halt online academic activities on the premise that i) data bundles are very expensive thus, unsustainable for both students and lecturers, ii) absence of an ICT integration framework to guide its implementation in HEI, and lastly iii) the cry of the needy students whom e-learning has left out [27], [28]. Therefore, the requirement of training of computer applications to advance teaching as services must not be underestimated because superior content alongside advanced technologies may result into proper acceptance of technology in education for both teachers and their learners at all levels.

Regarding the utilization of social media for teaching, findings evidenced 60% of respondents use these platforms primarily for transmitting teaching materials, with very few

preferring to actively engage in teaching through them. These findings concur with those of [31] who noted that faculty members solely focused on formal learning with the aim of meeting the learning outcomes of their course unlike students who build online communities to support each other.

Additionally, 90% of participants use emails and WhatsApp as a means of communication for teaching activities and discussion forums. About 83% respondents use conferencing applications like Google Meet, and Zoom for attending or conducting classes. Learning Management Systems (LMS) are used by 66% of the institutions, while Enterprise Resource Planning Systems (ERP) are selectively used by 33% of the institutions. Supporting the notion made by [30], [31] for social media usage in support of academic communication, and online learning. In terms of teaching modes, apart from the recent COVID-19 disruptions, most institutions primarily employ a face-to-face teaching model but positive signals towards blended classes and flipped classes is observed which is in line with [29] that pointed out that blended classes generated optimum benefits for students compared to both online approach and conventional face to face. This shall narrow the gap between students from developing countries and those from developed countries as [27] noted that students from developing countries score lower than their counterparts in western countries when it comes to online learning and assessing. Generally, institutions have made investments in e-classrooms, computer labs, and similar resources. However, there is still a lack of significant investment in networks, virtual technologies, and electronic resources in many of the institutions

Regarding the availability of technology enhanced teaching materials, the survey results indicate that 90% utilized PowerPoint presentations, and 80% incorporated activity-based sheets, and notes generated using word processors, and over 66% reported the use of digital images and photographs. These findings concur with those of [32] that acknowledge that information delivered by various multimedia channels present a significant reinforcement leading to greater retention and thus improving learning. Further, it plays directly into findings of [33] that point out the pedagogical advantage of digital content. However, the utilization of simulations, including e-simulations, blogs, social bookmarks, and open textbooks, was reported as insufficient. These are similar to views of Apaza-Yllachura at el. [34] and Qingtang [35] where respondents reported being least familiar to Augmented Reality tools. In addition, open education resources like OER, Saylor Academy, MOOCs, and MIT Open Courseware have not been effectively utilized to enhance teaching in Higher Education Institutions (HEIs). The exploration revealed that 64.4% of respondents have received training and retooling in the use of ICT for teaching, and 75% have participated in online training. Despite the substantial use of ICT and related teaching materials, respondents agree that there is a lack of detailed policies to guide the use of ICT in teaching in a broader context.

In summary, the respondents concur that Higher Education Institutions (HEIs) are in the early stages of adopting technology, and there is a significant amount of work ahead. To address this, institutions should actively engage their staff in learning advanced technologies to improve information delivery to students and enhance access to college resources. While this approach is advisable, institutions must allocate financial resources to support the integration of ICT. Moreover, it is essential for institutions to recognize the potential of emerging technologies such as AI, Cloud computing, and IoT in enhancing teaching, and learning within HEIs. It is worth highlighting that teaching with technology can be engaging and enjoyable. However, it is crucial to strike a balance between traditional teaching methods and technology-driven approaches.

6 Conclusions

In this study we created a TaaS framework that defines component of Technologies that an institution can effectively adopt and use information technology to deliver teaching as a service. The researcher discovered that higher education institutions in Uganda are in the early stages of adopting technology for teaching. Even if there seems to be sufficient infrastructure, we emphasize the need for institutions to engage their staff in learning advanced technologies and allocate financial resources to support ICT integration. We highlighted the potential of emerging technologies like Artificial intelligence (AI), cloud computing, and Internet of Things in enhancing teaching, and learning. Balancing traditional teaching methods with technology-driven approaches is considered crucial. In future work, we envisage to conduct studies to investigate several aspects of pedagogical approaches, integration of AI and machine learning driven learning processes, equity and Access, interdisciplinary collaboration among others. This will enable comprehensive understanding of TaaS to transform education.

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Appendix A: Interview Protocol (Cohort 1)

1. Tell me about your teaching experience using ICT tools. How has it been?
2. What are the most important things you consider when teaching based ICT?
3. Do you consider based teaching as a service teaching?
4. Tell me how what instructional activities you use in your technology-based teaching?
5. what tools do you use in teaching?
6. Can you share with me how you use the technology tools for teaching?
7. Do you often need help while using ICT to teach? Please give examples.

8. Are there policies in your institution that help you govern the used of ICTs in your institution? share with me those policies
9. if we were to design a framework, what would want to be included? Please give me the purpose(s).
10. Tell me about your experience designing learning contents frameworks? Please give an example.
11. Can you share with me the resources you use to design teaching frameworks?

Appendix B: Interview Protocol (Cohort 2)
1. From the previous encounter with experts we identified the following components, we named the framework as TaaS, is the name representative and descriptive of the use of information technology at HEIs.
2. could you ascertain that the component of TaaS is correct?
3. What other components should we incorporate in designing the framework? Can you share with me more examples.
4. Can you share with me how you incorporate diverse learning resource in framework?
5. What instructional activities do you use to promote the use of ICT in teaching? Please give an example.
6. What are your perspectives on this framework on ability to teach well?
7. Can you share with me how you promote quality assurance in ICT based teaching?
8. How do you use communication tools such as emails, online chats, videos, and discussion board in designing framework? Please provide an example?
9. Describe your experience designing framework and facilitating an online course? Please explain with examples.

Appendix C: Interview Protocol (Cohort 3)
1. Describe the benefits of designing TaaS framework? Can you share with me more examples?
2. Describe the benefits of TaaS framework to teachers, students and administration? Give an example.
3. What are the major challenges encountered in designing framework? Please provide specific examples.
4. Describe the strategies you use to address the challenges in designing framework? Please give some examples.
5. How can use TaaS framework to differentiate your teaching using teaching TaaS? Please give an example