Towards Sustainable Educational Management: A Best Practice Model for Digital Assessments in Higher Institutions of Learning in Uganda

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Abstract

This study was conducted in institutions of higher learning from different regions of the country. The participants included students, academic staff and technical staff. Numerous digital assessment-related challenges experienced during the Covid-19 were identified such as the slow Learning Management System (LMS), and failure to access the digital assessment system, among others. Data was collected through closed-ended questionnaires and interviews with key informants. Quantitative data was analysed descriptively using R, whereas qualitative data was analysed using Amos. Reliability and validity of the questionnaire were tested by Cronbach's alpha coefficient and Kaiser-Meyer-Olkin (KMO) test, respectively. The results were ranked based on the challenges that appeared most frequently to the least presented. A best practice model is presented with guidelines and measures for achieving successful administration of digital assessments for all stakeholders in the education ecosystem. It is anticipated that the successful adoption and implementation of the model will lead to effective and sustainable education management. Design science, an artefact-based methodology, was used to support the design of the model. The design followed design science-recommended steps. The model is, however, yet to be validated among the body of experts.

Keywords: *Sustainable education; Artificial intelligence; Best practice; Design science; Digital assessments.*

Introduction

Sustainable education requires the active participation of key stakeholders in the education ecosystem to achieve national social, economic and environmental goals, and also to eventually positively impact the standards of living, economic well-being, as well as the social and health welfare of people. Sustainable Development Goal 4 (SDG4) advocates for sustainable education through inclusive and equitable quality education and the promotion of lifelong learning opportunities for all (Johnston, 2016; United Nations, 2016), Vision 2040 prioritises education as a key strategy to the realisation of economic development and achievement of middle-income status through human capital development and empowerment (National Planning Authority, 2020). An education system involves teaching, learning and assessments. While teaching and learning remain important, assessments are a core and central part of education because they determine academic progression through different education levels. Assessments are an indicator of whether teaching and learning have been successful. They are also an avenue for judging the level of knowledge acquired by the learner (Begnum & Foss-Pedersen, 2018b) and for demonstrating understanding of the curriculum (Oldfield et al., 2012). However, if not well managed, assessments can break the education system or institution. This way, to ensure the credibility and quality of assessments, institutions establish examination policies which also have to be in unison with assessment policies stipulated by the NCHE, a supreme government agency that supervises higher learning education institutions (NCHE, 2020).

To foster academic progress during the Covid-19 lockdown, online learning was adopted through which digital assessments were administered following guidelines from the NCHE (NCHE, 2019; NCHE, 2020). Digital assessments refer to web-based assessments conducted online either through the internet or intranet using a computer system (Hameed & Abdullati, 2017; Begnum & Foss-Pedersen, 2018b). Because of a lack of specific procedures and national policy on digital assessments, different institutions conducted digital assessments based on their capacities. In the process, various challenges were experienced by the learners, assessors and technical support teams. This resulted in inadequacies and operational flaws that compromised the quality of teaching, learning and assessments. An exploration of experiences of digital assessments during Covid-19 period revealed that learners engaged in assessment malpractices such as the hiring of mercenaries and the practice of plagiarism. Learners also experienced various challenges such as loss of work, lack of devices, poor bandwidth, and power outages, among others. The challenges compromised the authenticity and integrity of the process of the digital assessment and violated the existing institutional assessment policies.

Information technology (IT) remains an essential tool to support equitable access to education. The education service providers should ensure the existence of IT infrastructure to support personalised learning, high-quality instruction and collaboration (U.S. Department of Education Guide, 2017). The emergence of new technologies presents a potential for enhancing digital assessments to achieve the required quality, authenticity and integrity, which are the antecedents of quality and sustainable education (Lim et al., 2023). More specifically, the use of technologies like artificial intelligence (AI) will enforce increased engagement and creativity among learners, personalised learning experiences and provide on-demand access to learner information as well as tracking learner activities during digital assessments (Dawani, 2023; Marrone et al., 2022). However, the lack of best practices has hampered the exploitation of modern information technologies to their full potential to benefit educational management. Best practices are essential to guide the institutions, assessors and learners to progressively integrate technologies into the existing practices for enhanced digital assessments (Asian Development Bank, 2009).

This paper presents a best practice model to support the effective integration and use of modern technologies such as AI to enhance digital assessments for sustainable education management.

Purpose

Achieving sustainable educational management requires sustainable practices that involve the use of technology. The exponential growth in education technology and supporting infrastructure has transformed teaching, learning and assessment. However, institutions of higher learning have been slow in adopting, adapting and integrating these technologies (Aruleba et al., 2022; Gupta et al., 2020;

Elangovan et al., 2021) into their teaching, learning and assessment practices. Where adoption has been achieved (Raaheim et al., 2019), there is limited exploitation of the full potential offered by the technologies, specifically to enhance digital assessments (Beleulmi, 2022; Gupta et al., 2020).

The non-existence of nationally established practices, such as a national digital assessment policy to inform institutional policies about the integration and use of technologies such as AI, is a challenge to which the flaws in the digital assessment could be attributed. The recent use of digital assessments during and post-Covid period to assess learners in institutions of higher learning exposed a number of challenges. These challenges require attention if digital assessments are to attain the quality and integrity demanded for standard digital assessments in institutions of higher learning. Technologies such as AI present high potentials to enhance digital assessments to foster sustainable educational management. This paper seeks to present an exploratory assessment of challenges encountered when institutions of higher learning adopted digital assessments as part of Open Distance E-Learning (ODeL) during and post Covid-19. It also explores the role and integration of AI in digital assessments to achieve authentic and standard assessments on all fronts for the learners, assessors and institutions of higher learning. A best practice model is presented to guide the integration of AI for enhanced digital assessments as a means to sustainable educational management.

Literature Review

Educational management

Education management is intended to effectively and efficiently create and maintain environments within educational institutions that promote, support and sustain effective teaching and learning (Lynch et al., 2020). It is a routine operation for an institution to plan, organise, direct, command, coordinate and control activities intended to accomplish the functions of education. According to Evan and Gracious (2020), education management utilises human and material resources in the most efficient manner in teaching, extension work and research and makes effective use of administrative tools, education software and best practices (OECD, 2016).

As a continuous process, education management demands sustainable approaches (Ahmed, 2022) for it to remain sustainable. However, the lack of planning prevents the existence of strategies for sustainable education management. During Covid-19, the NCHE developed guidelines for emergency Open Distance E-Learning (ODeL) for institutions of higher learning. However, these only lasted during the emergency period and currently they are no longer operational (NCHE, 2020).

Sustainable educational management

Sustainability is about creating consistent and continuous practices. In education, sustainability is about creating change in the educational culture that embodies the theory and practice of sustainability (Brunnquell & Brunstein, 2018; Sterling, 2009). It is a learning process involving future-oriented decisions to support people to understand the world in which they live, as well as its complexity and interconnectedness of problems, by developing new knowledge and skills necessary for a sustainable future (Holfelder, 2019).

Education management, while guiding planned change, must be responsive to unplanned, disruptive change created by rapid changes in both social structures and cultures as well as advances in digital technologies (Lynch et al., 2020). Moreover, it must be responsive to both global and local changes caused by technological advancements that directly impact teaching and learning, changes in the curriculum in terms of pedagogical and assessment practices, and evolve to effectively meet the needs of educational systems.

The resilience of the education system to technological, social, cultural and economic changes determines the effectiveness and efficacy of management practices. Effectively and innovatively managing change is the primary challenge facing educational management locally, regionally and globally. However, the Covid-19 period exposed the lack of resilience of Uganda's education system to disruptions, and the lack of readiness to changes in support structures. An education system is deemed to be flexible to adapt to changes such as integration of new technologies.

AI and sustainable education

UNESCO projects AI as a key driver of the achievement of sustainable development (UNESCO Digital Library, 2019). The digital evolution has been enormous, leading to the emergence of specific technologies known as education technologies, the most common of which are the LMS. The integration of AI into education technologies is producing new teaching and learning solutions, with lasting experiences. AI systems display intelligent behaviour by analysing their environment and taking action, with some degree of autonomy to achieve specific goals (Boucher, 2020). The adoption of AI in education, especially in digital assessment, empowers learner performance (Dhara et al., 2022). In addition, AI educational assessment tools provide benefits such as improving the accuracy and efficiency of assessments, providing personalised feedback for students, and enabling teachers to adapt their teaching strategies to meet the unique needs of each student (Owan et al., 2023). This means that AI is a technology that has revolutionised the education system, highly impacting the way education is delivered and assessed, which may lead to better educational outcomes for all key stakeholders, i.e. learners, academic staff and government. AI puts the teacher in control and reduces the burden of learner management. In most institutions of higher learning, teachers devote most of their time to checking homework and assessment documents, which absorb teachers' training and research time. Therefore, intelligent systems (Holstein, McLaren, & Aleven, 2017), didactic robots (Chevalier, Riedo, & Mondada, 2016) and other AIs can lend a hand to the teachers in solving these continual tasks mechanically.

AI exploits for digital assessments

Digital technologies are core to the assessment process, from the presentation of questions to saving of the learners' responses for evaluation. Technology-enabled learning processes create data every time learners get online. This data can be exploited for learner analytics to inform decisions and personalised learning experiences. AI can be employed to leverage learning data to enhance the digital assessments through a number of ways:

Assessments authenticity: AI algorithms can be used to ensure authenticity of both the assessments and the learner. Face recognition technology supports authenticity checks for learners during and after digital assessments (Andrejevic & Selwyn, 2020). Learners' pictures are continuously taken and the system is quick to detect unnecessary actions to stop the assessment (Owayjan et al., 2015; Sukmandhani & Sutedja, 2019). Use of authentic assessments mitigates impersonation-related challenges. This way, assessment integrity is protected and thus that of the institution.

Digital proctoring: The credibility of an assessment is highly determined by the ability for it to be fully proctored. During digital assessments, digital proctoring can be done remotely by a software system or live person (Hussein et al., 2020) to check on the learner, verify identity and check the workspace and surroundings for compliance with assessment requirements and avoid compromising the assessment.

Learner analytics: Leveraging assessment data, AI can support building models to predict learning outcomes and behaviour like engagement collaboration, motivation and performance (Almusaed et al., 2023). This way, personalised and adaptive learning interventions can be undertaken for corrective purposes.

AI integration into digital assessments will support sustainable education management by creating new ways for representing knowledge and skills, assessing complex problem-solving skills, supporting and enhancing collaboration, increasing flexibility, enhancing feedback to students, recording student achievements, and facilitating the exploitation of student learner analytics locally and nationally (Timmis et al., 2016).

Key factors for successful digital assessments

To achieve credible and successful digital assessments, a number of internal or external factors come into play. Some factors can be generic to the different personas under study, for example, the behavioural attitudes of both the learners and assessors (Ghazal et al., 2018). Moreover, other factors may be

technological, such as the supporting infrastructure, while others may be situational, like the prevailing learning environments or the period of the assessment or the time required to do the digital assessment (Alyahya & Almutairi, 2019).

Technical factors: Access to hardware equipment, software, internet connection and training are fundamental requirements for the success of digital assessment systems, and are determinants of access to digital assessments (Cumhur & Çam, 2021; Levin et al., 2011). The Covid-19 digital assessments showed that students and learners were technically challenged (Başak & Ayvacı, 2017). Besides, the technical support structures are important to where users need help during digital assessments (Cumhur & Çam, 2021). Moreover, training of end users on the digital system and their application for digital assessments remains important (Johnson et al., 2016).

Social environmental factors: In the context of digital assessments, end users (academic staff and learners) attitudes and beliefs are crucial factors in determining the success or failure of digital assessments (Kelly et al., 2023). According to Mahlangu and Makwasha (2023), the benefits of digital assessments are associated with positive perceptions while the challenges form the negative perceptions. Institutions of higher learning need to devise ways to promote positive attitudes that can optimise the use of digital assessment systems (Mahlangu & Makwasha, 2023; Valdez & Maderal, 2021). To influence users' acceptance of digital assessment systems calls for innovativeness, quality, knowledge sharing and trust (Almaiah, 2020). Therefore, transparent regulation of digital assessments coupled with authenticity will make the digital assessment process competent (Khan et al., 2021).

Government factors: A government's role in education is to fund, direct or regulate the sector (Schleicher, 2020). Funding support should target institutions with digital platforms and tools for distance learning, affordable devices to learners, and training school staff in methodologies and techniques for distance learning (Ministero dell'Economia e delle Finanze, 2020). A government's role is vital for the success of digital assessments by establishing supportive national policies that inform other policies at institutional level (ElSaheli-Elhage, 2020). Governments need to support the massive adoption and use of digital assessments by supporting institutions to invest in infrastructure, lower internet costs, ensure that there are enough information communication technology (ICT)-trained technicians to provide technical support, increase salaries and ensure universal access to computing devices (Bariu, 2020).

Best practices for digital assessment processes

Learning institutions should aim to establish digital assessment processes that are effective and efficient to ensure assessment authenticity, integrity and security. This requires following a set of practices:

Learner practices

Learners should observe trust and honesty during digital assessments regardless of their moral philosophy (Verhoef & Coetser, 2021). Further, learners should trust the staff to set fair digital assessments and to grade fairly to overcome the pressure to engage in malpractice.

Institutional practices

a) ***Continuous capacity development:*** Capacity development is the process whereby these actors as a whole unleash, strengthen, create, adapt and maintain capacity over time (De Lauri, 2020). Capacities should be upheld at individual, organisational and environment levels. According to UNDG, (2017). Individual capacity development calls for improving individual skills, knowledge and performance through training, experiences, motivation and incentives. The organisational level requires improving organisational performance through strategies, plans, rules and regulations and strengthening organisational systems, processes and roles and responsibilities. An enabling environment calls for an improved policy framework to address issues that compromise academic integrity. The legislative environment should be all-embracing for institutions regardless of capacity or geo-location. Capacity development for digital assessments should create a change process through which learners and institutions engage in a set of learning methods to develop and acquire

knowledge, skills, know-how and tools that strengthen their ability to effectively engage in the digital assessment process (Board & Programme, 2020). This implies that in order for institutions of higher learning to perform appropriate tasks effectively, efficiently and sustainably, they must incorporate capacity development as a key driver of any process of change and transformation, be it individual, organisational or societal (O'Toole, 2019).

b) ***Digital preparedness:*** The effectiveness of digital assessments largely depends on the readiness of the digital educational environment, the level of digital literacy and the competence of the academic staff who assess the learners (Mitrofanova et al., 2020). According to Dancsa et al. (2023), online digital tools are software, applications, technologies, plug-ins, add-ons or websites that are accessible via an internet connection and enhance learners' ability to master the knowledge they need to learn. These include LMS and digital assessment tools. These tools can be used to deliver content, measure learner progress and provide feedback. For best practice, institutions should be continuously ready with digital tools that can support digital assessment, which are continuously tested for resilience against operational failure or security loopholes.

c) ***Adopting artificial intelligence (AI) support in digital assessment***: AI can support and build superior digital assessment systems relying on data about the curriculum, subject area and learning activities that each student is completing, and a log of student activities. AI-enabled assessment systems assess learner skills, such as collaboration and persistence, as well as students' characteristics, such as confidence and motivation (Swiecki et al., 2022). Several AI techniques, such as natural language processing, speech recognition and semantic analysis, can be used to evaluate learning, and an appropriate mix of tools will go a long way in making the AI-based digital assessment system successful (Luckin, 2017). AI-powered tools and applications improve educational measurement, including assessment and evaluation. Moreover, these tools can provide educators with valuable insights into student performance, learning outcomes and instructional effectiveness (Owan et al., 2023). For example, AI-powered assessment tools can analyse student responses to assignments and provide personalised feedback to help students identify areas of strength and weakness (Nazaretsky et al., 2022). These tools can also provide lecturers with insights into the effectiveness of their instruction and identify areas where they may need to adjust their teaching strategies (Owan et al., 2023). In addition, AI-powered tools can help automate many aspects of the assessment process, saving time and reducing the burden on lecturers. For example, AI-powered grading tools can analyse students' essays and provide feedback on grammar, structure and content, reducing lecturers' time grading assignments (Tira Nur Fitria, 2021).

d) ***Integration of AI with learning management systems***: Educators can use AI assessment systems to assess student knowledge, save time on grading and provide students with immediate feedback on their performance (Bassey et al., 2020). AI-powered tools can also help identify students at risk of falling behind or who can benefit from additional assistance or remediation (Orsi Koch Delgado et al., 2020). These tools can analyse students' data, such as test scores and attendance records, and identify patterns that may indicate a need for intervention (Sharma, 2021). This can help lecturers to provide targeted support to students who need it most (Owan et al., 2023). AI assessment systems reduce paper, invigilation, space and transport allowance costs (Gammelgaard Nielsen & Petersen, 2013). However, studies relay that the cost of AI assessments is high, with the initial outlay being much greater than the ongoing development and maintenance costs (Owan et al., 2023). This, however, is in contrast to the human resources-heavy exam systems, for which the costs inevitably rise each year due to the increasing number of students, and therefore the increasing number of examiners and the cost of inflation (Appiah & van Tonder, 2018; Natumanya et al., 2021; Osuji, 2012).

However, caution should be observed for generative AI tools such as ChatGPT which have been misused by learners during digital assessments. The worst case has been the that of anti-plagiarism failure to detect AI-generated work. As Owan et al. (2023) state, other issues border on detecting text written by AI tools using other AI tools. Best practice requires using contextualised assessments that ChatGPT may not easily attempt.

Ethical concerns have been raised, with a number of scholars arguing that AI has come to stay. Nonetheless educators should seek ways of guiding learners on the ethical use of AI tools to maximise their benefits (Halaweh, 2023; Javaid et al., 2023). Building a resilient digital assessment programme entails thinking ahead about changing standards, curricula, educational tools and technology (Assessments, n.d.; Coalition, 2020; GLANCE, n.d.; Kohn, 2023). Moreover, whatever strategy you use to address digital assessment, make sure it supports a long-term vision for building a reliable, robust and flexible infrastructure for teaching and learning (Bourdeaux, 1981). Learners are expected to exhibit ethical behaviour and control the urge to employ AI tools to attempt their assignments.

Methodology/Approach

The major outcome of this study is a best practice model to guide institutions of higher learning to conduct quality and authentic digital assessments for sustainable education management. To develop the model, the design science (DS) method was adopted. DS is a methodology well applied in information systems research, leading to the development of artefacts relevant to the community (Aier & Gleichauf, 2010; Arnott & Pervan, 2012; Peffers et al., 2007, 2014; Zhong & Liu, 2010). DS follows three key cycles: relevance, rigour and design cycles (Hevner, 2007; Hevner et al., 1996, 2004). Following the exposed digital assessment challenges, the value of assessments in the education cycle and the desire for an authentic assessment environment motivated the desire to solve the existent challenges, thus the *relevance cycle*. Moreover, as a result of the pandemic, many institutions of higher learning adopted online teaching and digital assessments to allow for the continuity and progression of learners. However, digital assessments have been challenging for both learners and academic staff due to technical, academic and ethical issues. This has, without a doubt, affected the quality of the digital assessments, leaving much to be desired about the integrity of the entire process. This study was intended to provide a solution in the form of an artefact that would improve the digital assessment process in a way that addresses the challenges and ensure security and integrity of digital assessments. The artefact is a needed solution to cater for ad hoc situations.

The *rigour cycle* supported the link between the scientific theories with the knowledge of the industry experts that would build the trustworthiness in the research. This has been explained in the methods, methodology and statistical techniques herein.

The *design* cycle supported the actual construction of the artefact in the form of the best practice model. This cycle will further support model evaluation against design requirements.

Design science describes six steps to accomplish research: Problem identification and motivation; defining the objectives of the solution; design and development; implementation, evaluation and communication/conclusion. The model fits into the design science steps as demonstrated below:

In step (1) the motivation of the study is highlighted. Institutions of higher learning were not prepared for digital assessments, much as they administered assessments amidst the prevailing circumstances where institutions of higher learning lacked specific procedures and a national policy to successfully guide the digital assessment process. As a result, many challenges were faced by all parties involved, i.e. the learners, academic staff and the institutions themselves. The future of learning points to technology-mediated learning and assessments, so early preparation of stakeholders through a guided best practice model is timely. In step (2), the objectives of the design of a best practice model for digital assessments purposed to guide effective administration of digital assessments were set out. The model is designed and presented in step (3). While in step (4), the artefact is to be implemented in institutions of higher learning (both public and private) that have fully adopted digital assessments as part of their examination process. This will ensure that they effectively utilise and optimise the digital assessments while maintaining the integrity and authenticity of the assessments. In step (5), which involves expert evaluation to be used following peer reviews with subject matter experts, the artefact will be shared and assessed by one or more experts in the education ecosystem. Their feedback will help to evaluate the artefact for future updates. Lastly, in step (6) the application, value and contribution of the model will be communicated through workshops, conferences and journal publications. All stakeholders in the digital assessment ecosystem will be targeted.

Sampling and data collection

Data was collected from a sample of 362 participants from regional institutions of higher learning. The participants included learners, academic staff and technical staff. Key informants that were interviewed included heads of academic units, learners, technical staff, academic registrars and IT managers. Questionnaires, interviews and experiential observation were used in data collection while RStudio was used in the data analysis. The questions asked during the interview focused on the challenges faced by learners while sitting and administering digital assessments. To be specific, the challenges were grouped as technical challenges and end-user challenges to distinctively bring out the most pressing challenges that need to be addressed urgently.

To assess the genesis of digital assessments, technical staff and other key stakeholders (academic registrars, deans, e-learning and IT managers) were categorically asked why there was a need to adapt to digital assessments, the challenges they faced in their respective roles and based on their expertise, and the challenges academic staff and learners faced. This helped to double-check and validate the challenges presented by the academic staff and learners. The participants were also asked to provide solutions to the challenges faced and these guided the best practice model and formed part of the recommendations. Direct observation supported the collection of evaluative data from the students since most of them carry out their digital assessments on school premises. This aided a deeper understanding of the assessment environment and different units in the assessment practices. Responses in all the questionnaires were based on a 5-point Likert scale. Scale questions were used because they are easy to understand and allow for differing opinions to be shared to some extent. For instance, each participant was requested to indicate his/her stance on each continuous capacity development statement as 1 (Strongly disagree), 2 (Disagree), 3 (Uncertain), 4 (Agree) or 5 (Strongly agree). To determine the goodness of fit of the model (GFI), the Amos tool was used.

Reliability and validity test

Reliability in the research instrument was assessed using Cronbach's alpha coefficient (Cronbach, 1951). An alpha coefficient of 0.7 or higher for an individual test variable will show that the instrument was adequate (Nunnally & Bernstein 1994). The Cronbach's alpha value of the student questionnaire was 0.731, the academic staff questionnaire was 0.712, while the technical questionnaire was 0.701. This indicated the desirable reliability of the three questionnaires. For validity, the Kaiser-Meyer-Olkin (KMO) test was used to ensure that each phase of the chosen research methodology rigorously adhered to the highest standards of quality. The KMO value 0.850, which is higher than the minimum value of 0.6 suggested by Kaiser (Shrestha, 2021), was acceptable, hence the three questionnaires had constructive validity. Ethical considerations were observed. The research was done while observing the requirements of the Data Protection and Privacy Act, 2019. Consent was sought from the participants before engaging them and data was anonymised. Participation in the study was completely voluntary.

Findings/Results

With guidance from the NCHE and the Ministry of Education and Sports (MoES), institutions of higher learning conducted assessments digitally using LMS for learner progression. This way, more than 58 institutions of higher learning (both public and private) adapted their assessment processes and activities into digital mode.

Institutions of higher learning have come up with various digital modes of assessment including open book assessments, quizzes, oral assessments and recorded videos, among others. Some of the platforms used for the digital assessments include e-learning platforms, Zoom, WhatsApp and email. Lecturers upload student assessments to the institutions' e-learning platform and students are given a deadline and guided on how to proceed with the assessments.

Some assessments allow students to handwrite their answers, scan and upload them to the respective e-platforms for submission. Some assessments are administered in real time and are accessible on the e-learning platforms. Some digital assessments are in the form of group assignments and presentations, oral assessments and recorded videos, among others.

a) Respondents

The respondents are summarised using the chart in Figure 1.

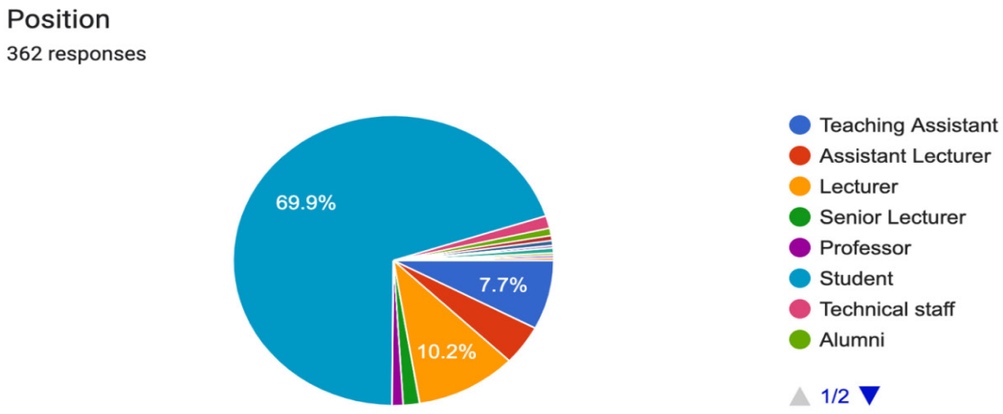

Figure 1: Respondents by category

The respondents included academic staff (from the rank of teaching assistant to professor), students and technical staff.

b) Existent challenges for digital assessments

For lack of proper planning and preparedness, efforts to administer digital assessments encountered a plethora of challenges. Various students experienced challenges as summarised in Figure 2. The challenges were categorised according to user-based versus infrastructural challenges. Among the user-based challenges, the slow LMS became more pronounced, followed by failure to access the digital assessment system. Other challenges experienced by students as users included failure to download the assessment, failure to upload answers, lack of a device to use, unintentional upload of a wrong assessment answer or unintentionally uploading answer in a wrong forum, the use of a borrowed device, and the assessment answer being uploaded with a different profile.

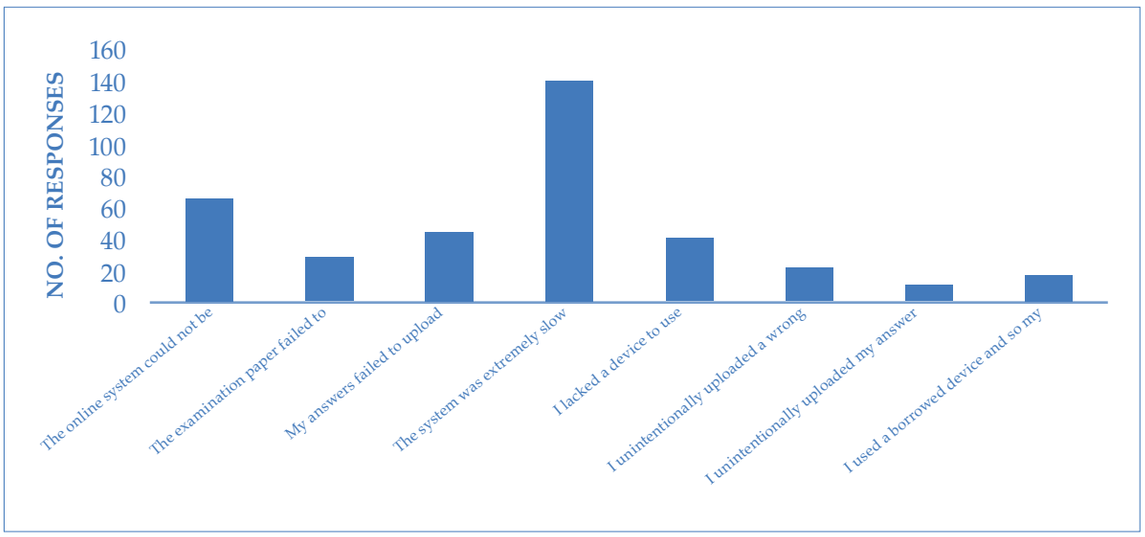

Figure 2: Summary of user-based challenges

Many of the user-based challenges were, however, dependent on infrastructural challenges, which are presented in Figure 3. The outstanding challenges were poor bandwidth and the digital assessment

system, and lack of technical support. Other challenges included lack of a smart device to use, failure to borrow a device to use, lack of a public facility to use within the home area, power failure in the area on the day of the assessment, long distance travelled from home to find a facility to use for the assessment, lack of funds to pay in the facility, and timing of the assessment.

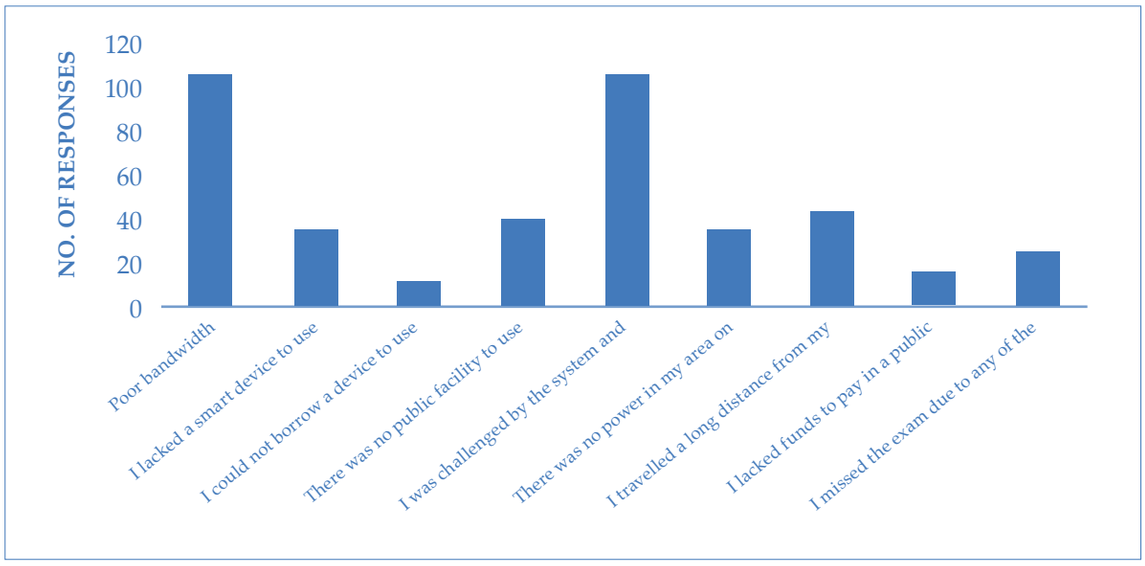

Figure 3: Summary of infrastructural challenges

The findings further revealed various challenges among the academic and technical staff. Many academic staff claimed that they were not used to digital assessments and the technicalities surrounding it. For instance, one indicated: "I was not used to the digital environment more specially administering digital assessments."

At the time of Covid-19, they had not embraced digital assessments. However, they were forced to do so. Most of them were unfamiliar with the digital assessment activities, hence resisted the change. Many of the participants cited age as one of the dominant factors. They revealed that since many of the older academic staff were not tech savvy, they tended to build negative perceptions around the technology, in this case digital assessments. For instance, one of the participants had this to say:

> I speak for my staff members. I think the ability to use certain programs for instance like Moodle to navigate online has been a problem for some. For some, it's because they lack knowledge around their using these applications. For some, I think it is just a matter of age, especially the older ones struggle to utilise or perhaps have digital assessments for the students.

Several participants pointed to the lack of ICT skills to effectively use computers. Moreover, even where the academic staff were IT (Information Technology) competent, pedagogical inputs were lacking to administer digital assessments. Having been used to the traditional mode of assessment, the academic staff found digital assessments challenging. Other challenges cited by the participants included misunderstanding ODeL, network issues, cost and expiry dates around the data.

The technical teams also doubled as trainers in digital assessment systems because of their hands-on knowledge and expertise in the system. The support of the technical team was key to understanding users' problems. However, the technical teams also faced quite a number of challenges. For instance, many cited infrastructure and equipment challenges. Infrastructure in terms of resources required to run a robust and effective LMS, space available on the server, specifications of the server in terms of how fast the server responds and how many users the server can support at the same time, and network connectivity of the infrastructure. Storage of student files/work as well as photos taken from proctoring was also a big challenge since storage was not enough and, where the system failed, students' work would get lost. Such major infrastructural issues resulted in service outage that hindered the digital assessment process. It was

further reported that institutions of higher learning lacked equipment. However, some institutions had the plug-ins already developed even for simple tools like a safe examination browser, though, basing on the kind of end users, it is not easy to roll out some of these tools. For example, to use a safe browser, it would require all users to have it installed either on a desktop or on a laptop since it cannot be installed or imported on mobile devices. However, one of the participants stated: "We have been using the safe browser but the issue with the safe browser was that some students who were using phones and not laptops or desktops, the safe browser would not activate on the mobile."

To confirm this, another claimed that in the survey they carried out, 92% of the end users in their institution used mobile devices to access the digital assessment system. This implies that the majority of the end users did not have the necessary equipment that is desired for effective and authentic digital assessments, which forced institutions to compromise on some of these tools. Along similar lines, another participant stated that they had to disable the safe exam browser and the proctoring tool which requires users to enable their web cameras and without which these tools could not allow the users to go ahead and access the digital assessment system.

The technical participants also cited the issue of constant hackers trying to hack into the system and acquire information about the platform without authorisation. Another challenge cited is system usage, especially when using Moodle, which has a number of packages/modules available. The participants claimed that sometimes it was hard to ensure that there was seamless user experience because the technical teams were composed of staff with different competencies, which became an issue. Some technical staff might accidentally delete an activity which was an assessment, results or attendance of the students who had taken the assessment. Segregation of duty and performing user metrics to understand exactly whose role did what when it came to the digital assessment system was another technical challenge that was reported. Moreover, such detail was not really documented. Through the discussions, it was also discovered that the technical staff lacked the ability to impart the technical skills to the end users. Many attributed this to the fact that technical staff were not trained teachers so they delivered content in a blunt way. In addition, there was not much interest in workshops and training even among the technical staff who had to go through training. One participant remarked that whenever there was a training or workshop, sometimes they felt like they knew everything, while some choose to conceal some of the important information, which led to some inconsistency on their part.

The majority of the technical participants also reported that academic staff and students had challenges with the user interface and navigation. They claimed that they had received many complaints from both categories of users having issues in adapting to some of the changes in the user interface after a system upgrade. One participant stated:

> We did a system upgrade at the beginning of the semester; the system kind of looks different and we have had several issues. We have had students who have missed real-time assessments simply because they did not know where exactly on the new interface to find the assessment. … Of course, these changes were covered in our earlier extensive trainings, but most of the users we have do not attend trainings and workshops and sometimes they fall victim of some of these challenges.

A major concern cited was the challenge of setting the assessments by academic staff. It was reported that many academic staff did not know how to set digital assessments, some set wrong content and configured wrong answers on the system, while others uploaded heavy content, for example, a video of about 4gb which heavily drains the server resources on top of giving a very slow experience to the end users. They further stated that some of the staff were not well acquainted with the different content that they could easily upload, citing the debate on the number of questions that should be put in a real-time exam. It was reported that different departments were setting different numbers of questions. For example, one participant reported that in their institution, one department set about 100 questions to be done in a space of 60 minutes, while others set about 20 – 45 questions to be done in a space of 1 hour 30 minutes. Such inconsistencies confirm the lack of a standard format for digital assessments, which affects the overall quality. Moreover, another participant said: "Sometimes the content that is uploaded is not in the format which is supported by the system and this causes glitches and errors in the system."

Many technical participants reported that they had received several complaints from academic staff about the safety and integrity of the content uploaded on the system, further citing a major challenge regarding how to mitigate malpractice during digital assessments. One participant stated:

> We have come to witness that when it comes to digital assessments, we really don't have examination policies that are tailored for digital assessments. … Yes, I know there [are] the school rules and examination regulations, but some of these were tailored specifically for sit-in exams and this has made it hard to just come, drag and drop some of these policies on to the digital mode of assessment.

There was overwhelming request for support from the students and academic staff. Moreover, some of them did not know how to get the technical support in case they faced any issue.

Technically, several challenges related to the system and the available support were reported. In one institution, the participant indicated that

> …. the Learning Management System was well tested before the assessments could start. However, the time the assessment started, over 1,000 students went online and the system crashed five minutes after the assessment had started. Whereas we did the testing, we never conducted a system stress test and we paid for that.

In addition to the student challenges, one student participant indicated*:*

> When the paper started, I attempted the questions on the first page and navigated to the next one. However, the system kept in transition and later informed me that the time had elapsed. I ended up with a miserable mark.

In the findings, while 20.9% strongly agreed and 47.3% agreed that their institution had an ICT policy, 54.9% indicated that they did not have access to their institution's ICT policy. Moreover, 68.6% claimed not to have read and understood their institution's ICT policy. Statistics did not differ much on the e-learning policy, where 16.5% strongly agreed and 51.6% agreed that their institution had an e-learning policy, though 54.9% still claimed not to have access while 66.7% did not read and understand their institution's e-learning policy. This confirms that the majority of the participants were ignorant of the ICT and e-learning policies, yet these may guide on digital assessments. It is important to note that effective adoption and utilisation of digital assessment systems depends on the policies in place. Some participants suggested that these policies were available on their respective e-learning platforms, university websites and to everyone who needed them. However, this did not guarantee that learners and academic and technical staff would access and be well acquainted with the said policies. Probing further, it turned out that many of the participants were ignorant on the detail in the policies. Some were not even aware that such policies existed or about where to access them. One participant (a faculty dean as well as academic staff member) is quoted to have said: "Well, I'm not going to say anything about the e-learning policy. Yes, we do have it, it is there, but I have not quite read it but it is there and that's the other thing I think I'll be careful not to talk about."

Whereas one member of the technical staff is noted to have said: "On the issue of the ICT and e-learning policies, I wouldn't want to answer because there's someone in charge of the e-learning system. I think I would give you wrong information as a technical person."

The participant affirmed that the policies were available on the university website; however, he blamed ignorance about its availability on the lack of a reading culture among the people. Another participant indicated that policies did not clearly spell out the specific roles for students and academic staff – that they were generalised for all users. Nonetheless, 46.2% agreed and 44% strongly agreed that universities needed to develop and operationalise digital assessment policy frameworks to ensure that learning continued uninterrupted.

Discussion

Technology adoption must be followed with strategies to overcome associated risks. For example, the rise of ChatGPT must be carefully followed with ethical use, as well as sensitisation of the learners to avoid the syndrome of 'copy and paste'. Unethical use of ChatGPT would create a category of 'non-thinkers' who simply use generated data whereas ethical academic use would create a category of students that can reason with ChatGPT or even challenge its algorithms.

To achieve thorough integration of AI into digital assessments, a strategic process should be followed. These steps have been composed into a best practice model to support the utilisation and optimisation of digital assessments. This model was designed based on the practical solutions discussed with the participants who are key stakeholders along with the theory that guides practice.

Continuous capacity development

Capacity development is "the process whereby people, organizations and society as a whole unleash, strengthen, create, adapt, and maintain capacity over time", in order to achieve development results (UNDG, 2017). Capacities are grouped into three dimensions which are interlinked; individuals, organisations and the enabling environment/society are parts of a whole and for capacity development initiatives to achieve sustainable results, a holistic approach must be undertaken because the interdependence of each level influences the capacity development processes (Agency, 2011). The need for continuous capacity development resonates with the UNDG (2017) proposition of capacity development being preferred at three levels – individual, organisational and societal/environmental.

At individual level, capacity development enables individuals to embark on a continuous process of learning – building on existing knowledge and skills, and extending these as opportunities appear (JICA, 2003; UNDG, 2017). In institutions of higher learning, continuous capacity development advocates for training of staff and learners periodically during the administration and use of digital assessments. Institutions of higher learning should always plan, schedule and train users i.e. learners, academic and technical staff, in the use and administration of digital assessments. Such a plan should be a living document subject to continuous review and updates. The participants varied in their suggestions as some were in support of trainings at the start of the semester, while others favoured trainings in the middle, and yet others before the assessments. On average, four trainings were suggested per semester for both staff and learners and these would be internal trainings. It was also suggested that external trainers be brought in because people get bored seeing the same faces. Online training, consistent training and physical training should be included, too. External trainers should be engaged to come in and train users on how to design suitable digital assessments. For internal trainings, trainers/champions should be chosen from amongst the academic staff to help. The participants unanimously agreed that a lot of trainings/workshops on how to handle the new assessment methodologies were necessary. Suggestions were made to have trainings over the weekends and during holidays. Trainings should be made mandatory and part of staff development, not forgetting training in pedagogy. Once taken into consideration, continuous capacity development will equip learners and academic staff with skills to always respond seamlessly and aptly when the need for digital assessment falls into place.

At organisational level, it involves the improvement of an institution's systems, structure, processes and people in order to improve operations or services for increased success. For institutions of higher learning to thrive over time, capacity development should invest in adaptive functions, especially where future situations are unpredictable. This will enable institutions to better meet unknown future challenges. The study focused on technical preparedness, strategy and policy development, institution-based assessment centres, top management/leadership support, culture and LMS.

Technical preparedness

This parameter describes the structural technical requirements that must be in place or be implemented from the institution's side to ensure credible and authentic digital assessments. Some of the requirements discussed with the participants include high speed internet that is reliable. Institutions should partner with telecom companies to purchase bulk data and give it to learners and staff. This data should be enabled only for learning and assessment purposes and other applications should be blocked. This data should not have an expiry date/time to it. A certain percentage of school fees can be waived to cater for data. Institutions should create hotspots for the internet within their campuses. Institutions should create strategies that enable students and staff to access affordable hardware and licensed software for use during teaching, learning and digit al assessments. Such strategies may include, rewarding best students with learning

devices, partnering with financial institutions to provide computer loan schemes or extend interest free loans to students to purchase devices. Equipment, software and connectivity are strong determinants of access to digital assessments (Johnston, 2016). This implies that the implementation of digital assessments will not be feasible if learners and academic staff do not possess adequate computers and a fast, reliable internet connection. The technical requirements include:

a) *IP-based authentication*: Institutions should create secure access environments for digital assessments by the authorised learners. The use of IP address authentication enables the users to gain access based on the IP address assigned to the computer or device they are connecting with. IP addresses would be managed by the institution's IT department to identify the physical location of a computer. This way fraudulent access is limited to maintain the credibility of the digital assessment where each device would be clearly identified in addition to user identity management. ID chips should be a prerequisite where every student has to first log into the system and if they are not seen in the system, it means they are absent.

b) *Security and privacy*: This factor describes the act of compliance with the requirements for security and privacy of data. Security requirements provide assurance to users that their data, i.e. the digital assessment, is safe, secure, remains confidential, with integrity and available. Whereas privacy ensures the protection of private data such as learner biodata, grades etc. from unauthorised access. Security and privacy assurance overcomes challenges arising from fear of data loss where some students' assessments never reach the assessors or where grades are accessed without exclusion. Institutions must critically think about the security issue in the digital assessment system in the e-environment. Numerous institutions are adopting this innovative technique of conducting digital assessments. It would be beneficial for them to maintain their academic integrity in the education world (Zamrodah, 2016). This means that institutions need to strongly support the authentication of digital assessments to avoid cheating. They should use AI to ensure privacy and also to curb plagiarism.

c) *A robust Learning Management System (LMS):* This supports all-round access to digital assessments, learning materials and grades. The LMS must always be accessible, available and user-friendly. Institutions need to condition users to participate for example; All students to access results online. They may send mock assessments to enable learners familiarise themselves with the system. This assessment can be sent, for instance, two weeks earlier.

d) *Technical support*: This describes structured support services available to both learners and assessors before, during and after digital assessments. Support may take the form of digital chats, chatbots, the telephone, email support systems, and digital self-help with user-guided videos to send to the learners and staff to learn easily. Institutions of higher learning need to set up call centres to manage student queries during assessments and they should be managed by a reasonable number of technical staff to cater for the student numbers. Each programme should have a coordinator to run a WhatsApp group, obtain information from the students regarding the issues they face and devise ways to help them. Further, it is important for learners and staff to know how and where to access the technical support and such support should be versatile and technically grounded. This helps tackle challenges that were indicated in connection with learners and staff not being able to get immediate support during digital assessment.

e) *Leadership support*: This is an important factor for the success of digital assessments. The clear commitment and leadership of influential actors such as top management, who are the drivers of change, can lead to the success of this initiative.

f) *Culture*: In institutions of higher learning, culture is likely to drive the successes or failure of digital assessments. Many of the academic staff resisted digital assessments. Learners and academic staff were too attached to the traditional mode of assessment yet during Covid-19 and post-Covid, they needed to be flexible and adapt to digital assessments for continuity. They formed negative perceptions around digital assessments. However, both learners and staff need to be resilient, avoid short term plans or waiting for disasters to react. Institutions should always be prepared

and have the ability to switch from one mode to another seamlessly. Institutions need to advocate for change management to tap into the perceptions of academic staff who are still wedded to the traditional setting. To boost a positive culture that will support digital assessments, there must be continuation of blended learning, involving the development of specialised programmes relating to both content and assessment modes for only online learning to be presented by the institution to the NCHE.

g) *Strategy and policy development, specifically e-learning policies:* Successful implementation of digital assessments is premised on supportive institutional policies to guide assessors, learners and technical staff on the general use of digital assessment systems or LMS. The lack of policies creates subjective use of systems as opposed to objective use. Such policies must also align with the institution's strategic objectives. According to Khan et al. (2021), digital assessment systems must be aligned with the institution's long-term strategic plan, and institutions should raise the requisite resources and make learners aware of the essential guidelines required for the success of digital assessments and, thus, the implementation of such assessments. Educational institutions should provide proper guidance and support to the assessors and learners since such support is imperative for conducting the assessments effectively. Unfortunately, many institutions lack an ICT policy, or where the policy exists it is silent about e-learning guidelines. Moreover, the few organisations that have an e-learning policy lack a policy on digital assessments to guide best practice. In ad hoc situations such as obtained during the pandemic period, carrying out operations regarding digital assessments became difficult due to lack of policy guidelines. Institutions need to make sufficient effort to inform learners, assessors and administrators/technical staff about the policies and standards in order to ensure academic honesty at institutions of higher learning. Such discussions can help learners and staff to check their behaviour during digital assessments with the aim of building integrity. There should be a share point to share the policies. However, these policies should be available on only the necessary platforms, not public platforms. Staff and learners should be able to easily access the policies. With this, learners will be able to refrain from engaging in cheating behaviour during digital assessments. There is also need to sensitise policymakers and top leaders, and also for capacity-building of policymakers, academic staff and learners. The policymakers and top leaders will sensitise these people to issues of ICT. When there is management support or leadership support to this initiative, then it can be a success.

Institutional based assessment centres (IBAC)

Institutions of higher learning must create assessment or testing centres to cater for various exceptions, such as where students who are upcountry have connectivity problems, for students who cannot afford internet and devices, and where other infrastructures, such as electricity, are lacking. These centres must be equipped with the necessary technology to connect to the main campus and also to each other to play a social role. The establishment of institutional-based assessment centres would not be difficult, especially where most institutions have regional campuses, study centres and satellite campuses. The effort will yield several benefits, such as controlled and monitored access to digital assessments, proctored assessments, maintenance of social distance, and affordable access to learning and assessments, among others.

The centres can be at district level. However, on the downside, they would require a lot of investment. Institutions may look into investors who can support regions and provide costs they can look into. Setting up centres may also not be cost-effective since it would require a heavy budget and a great deal of manpower, which is tedious. It would be very difficult to conduct assessments since learners are highly diversified in their geo-location, hence it would be wasting resources. The cost of establishing IBAC in private universities is high and might result in more fees for the learners.

Societal/Environment level; This involves capacities in the society as a whole, or a transformation for development. At societal level, there are external factors that represent constraining factors that are outside the institution. It further describes the role that other players, such as government have to play in

order to ensure successful digital assessments, especially in ad hoc situations. The societal/environmental parameters are as follows:

a) *Policy guidelines:* These are issued by the key external stakeholders such as the NCHE with deliberate policy objectives and outcomes. During the pandemic, the NCHE issued operational guidelines for emergency ODeL. However, the policy lacked a structured approach to follow during digital assessments. Moreover, much as the policy advocates for digital assessments, the NCHE still insists on the physical infrastructure yet emphasis should be on moving away from the physical infrastructure. The policy guidelines should also have a uniform procedure, for example what system to use, the time taken on the assessments, and the equipment required. These standards must be approved and the licence issued to only those that meet the set standards. The policy guidelines implementation must also be monitored constantly or in real time.

b) *Public telecentres:* There is great need for government to revive public tele centres where all learners, regardless of their institutions, can sit digital assessments. This would require institutions to give government their specifications. Moreover, government can set up these telecentres at public universities, including their regional campuses to help manage them, rather than leaving them as stand-alone because nobody will care. The public telecentre will supplement the institutional assessment centres, making learning and assessment universal, cheaper, accessible and affordable. However, the successful application of the best practice model requires dedicated investment in infrastructure by learning institutions with the support of government in meeting the cost requirements, the establishment of e-learning policies that are cognisant of digital assessments and a follow-up of their effective implementation, sensitisation of both learners and academic staff about the need to maintain the integrity of digital assessments.

Recommendations from the participants

In light of the above challenges, the participants made several recommendations:

Institutions should be able to put up LMS and train/retrain both academic staff and learners on how to use them. Institutions should also conduct workshops for the technical team in areas of troubleshooting and running the system effectively, document heavily on how users are able to navigate and use the system from the technical perspective as well as end-user perspective. The academic staff and learners have an upper hand in determining whether to carry out digital assessments or not, hence the training/retraining should be consistent and mandatory. Moreover, students and staff should be conditioned to participate. Ample time should be given to the people who do the training. Key areas that require training include pedagogy, content creation and assessment administration. The training should also be blended, physical and online. One participant observed:

> Retraining has been key and part of what we do as an institution. And this has actually given us close to either 70% to 80% participation. Because at some point we felt that almost everyone was learning. Myself, if I would get about 300 calls in a day or plus on the onset, but as we were getting close to midway the Covid period, calls had lessened meaning that people had now learnt what to do.

Regular communication of system updates should be made to the end users to help them familiarise themselves with the changes and how to access it before the assessment. However, as the technical staff make these changes, they should make sure that they adhere to the principle of design and usability to make sure that the system does not change a lot to confuse the end users. They should also do several units and meta tests to make sure that whatever upgrade has been made will not give the end users any kind of challenge.

Institutions should bring in external trainers along with the internal trainers, because people seem to get bored with the same people coming in to talk about similar things. Trainers/champions amongst the academic staff should be chosen to help. This may improve on the attendance since the academic staff will be seeing familiar faces. In addition, interventions such as a help desk which responds on time and also records online tutorials to provide informed and impromptu user experiences for the end users. Collaboration with telecom companies/internet service providers is important. The government should

reduce the cost of the internet and also set up hotspots at key points, especially where the presence of students is suspected, for example around schools or near libraries. Institutions should ensure that the LMS is accessible at zero rate through the internet service provider. Institutions should buy WI-FI gadgets and install them in a number of spots. Infrastructural challenges need to be solved at national level.

The NCHE should come up with a uniform format that all institutions should adopt. This includes the system to adopt, procedures to follow, the timing and format of the digital assessments, and the equipment required. Digital assessment standards have to be approved and licences given to only those that have met the set standards. There should be a deliberate effort by the NCHE towards this initiative to see how best digital assessments can be regulated and guidelines can be given. Efforts should be geared towards policy change along with regular policy review that can contribute to a standardised approach when it comes to the digital assessments. The NCHE should develop policies geared towards the improvement of teaching, learning and digital assessments. These policies should be communicated extensively, and made available to everyone who feels they should have them. Share points should be put in place to share the policies. Institutions should have them on their e-learning platforms, websites since they are public documents. However, policies should be available only on the necessary platforms, not public platforms. Changes should be made in the guidelines to include emergency ODeL assessments. Institutions should also come up with a policy requiring all learners to use laptops/desktops as opposed to mobile devices which will allow for tools such as a safe exam browser to be deployed. As a result, this will improve the integrity and quality of the digital assessments.

Management support to such initiatives is key to ensuring a chance of success. The NCHE, MoES, deans and heads of departments should support such initiatives if they are to succeed. There is also need for policymakers in the country to support such initiatives as their support is important for its success.

Furthermore, there is need for sensitisation of the policymakers in the country and the top leadership as well as capacity-building of the policymakers, academic staff and learners. One participant shared that they had to write a paper that they presented to MoES requesting the ministry to advise the president and policymakers on issues of ICT/e-learning and digital assessments during the Covid-19 period.

More effort should be put into changing the mindset, especially among the old. These are people who went to school before the advent of computers and had little to no exposure to technology. They are simply digital migrants, so the learning curve among them is a little hard yet the learners are digital age students (digital natives) who are being taught by the digital migrants. These learners have been exposed to technology, they have lots of energy as well as the love and enthusiasm to try out new apps, which makes it easy to change their mindset. Both learners and academic staff should be encouraged not to look at this as an event in itself but, instead, as an initiative that has come to stay and that we must, thus, adapt.

Higher institutions of learning should benchmark against well-established institutions that have successfully implemented digital assessments. Tools like plagiarism checkers and AI should be embedded in the digital assessment systems to detect students who engage in malpractice as well as verify the true identity of the persons sitting the assessment. Moreover, proctoring, though a little expensive, should be incorporated. The proctoring tool can take learners' photos at intervals. One participant suggested, "AI should be involved in the whole process, although it needs a lot of money to fund."

Academic staff should be encouraged to set questions that shuffle for multiple choice and essay questions that trigger critical thinking to make it difficult for the learners to cheat but also maintain the integrity of the digital assessments. One participant commented, "You'd have many students sit in one room, when they call, you'd hear like these are in one room."

The government should deliberately come up with grants to support this initiative. There should be an increase in funding to the IT sector because, much as we are looking at being online 24/7 or at least at 99.9% availability, we must be able to upgrade the infrastructure and plan for business continuity by continuously assessing and making sure that necessary upgrades are done during off-peak hours. So, replication of services and related data/information should be key to business continuity. For instance, some institutions cannot afford to have a backup location yet it is crucial and calls for huge investment. In

connection with this, one participant had this to say: "Some institutions have always looked at IT as a cost centre, but I'm very happy that during Covid, it became a saving centre." So, government and institutions should stop looking at IT as a cost centre, but instead invest heavily in some of the infrastructure if we must head towards that transformative direction.

There is need to move away from exams to progressive assessments and these assessments, even when it is digital, should be all-inclusive. The physically disabled or visually impaired should be able to take the same digital assessment as the other learners. Assessments should not be only at the end of a programme. Many developed countries that we can benchmark against have moved away from the end-level assessments. Assessments should be activity-based in order to create an observable change in behaviour.

Institutions of higher learning should continue to teach and assess in a blended manner and not wait for situations to emerge that make planning difficult. They need to be resilient, avoid short term plans or wait for a disaster to strike before they react. They should always be prepared and have the ability to switch from one mode to another seamlessly.

The government can partner with institutions to set up learning centres equipped with the necessary technology to connect to the main campus and also to each other. These centres play a social role where different students or people can meet up to exchange knowledge and experiences. For ease of accountability and management, centres can be set up at the public university branches as opposed to stand-alone centres. They can also be set up at parish level. However, they require a lot of investment, hence the need to attract investors who can support regions to establish telecentres and meet facility operational and maintenance costs. Budgets at national and institutional levels should be reconfigured to cater for such initiatives.

Institutions of higher learning should always have a mechanism or a cloud provision server which is scalable in such a way that it can adjust to the number of requests available but also a platform that can scale down if the institution is not using a lot of resources so that it can save costs. The technical team should always liaise with top management and other relevant stakeholders within the institution to make sure that whatever is provisioned for the digital assessment system will not lead to service interruption. As one participant said, "Institutions need a solution where they know they are going to have an up-time guarantee of 99.9% and that they would recommend using some of the cloud services available."

There is need for robust technical support during the assessments because sometimes end users encounter issues and they do not know how to deal with them or how to contact technical support so as to get help. Institutions of higher learning need to have a fully detailed and dedicated support team during digital assessments so that in case of any technical issues they are able to get the support they deserve. They need to make sure that they have detailed, frequently asked questions and answers to the common challenges end users face or detailed user manuals that the users can read to get the help by themselves.

The Best Practices Model

Following the investigation of current digital assessment practices and recommendations based on primary data and expert opinions, substantiated with literature, this subsection presents the contribution in the form of the best practice model in Figure 4.

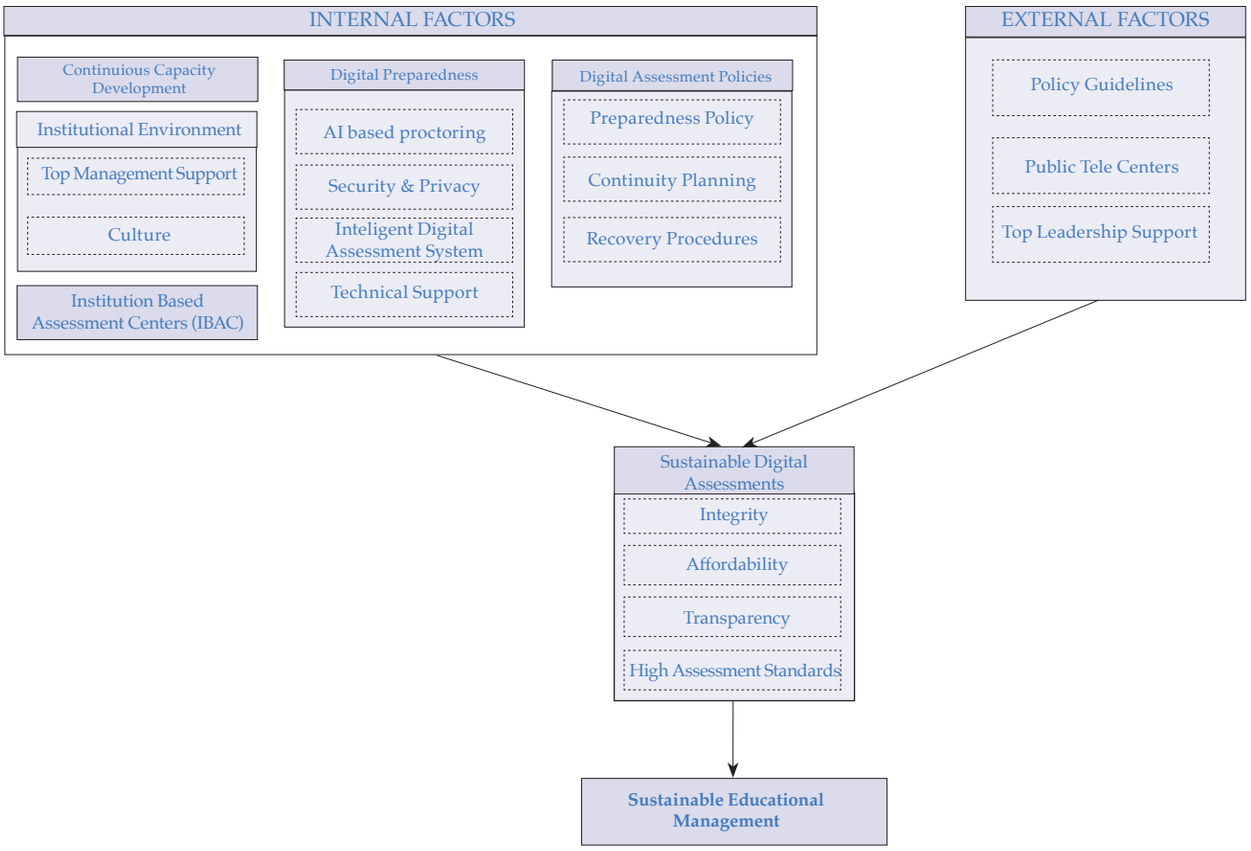

Figure 4: The proposed best practices model for digital assessments

***Source*: Primary.**

The goodness of fit index (GFI) was employed to calculate the discrepancy function necessary to achieve a perfect fit under maximum likely conditions of digital assessment practices (Jöreskog & Sörbom, 1984; Tanaka & Huba, 1985). The GFI outcome for the default model yielded a value of .786. according to Hu and Bentler (1998). Values <1 represent a reasonable fit, thus the suggested best practice measures and recommendations are fit for the existent challenges.

Conclusion and Recommendations

Digital assessment platforms are leveraging technology to carve a sustainable path forward in education. They demonstrate their commitment to digital transformation that promotes sustainable education. Assessment is universally recognised as one of the most important and powerful elements of an educational experience, as it provides observable evidence of learning, determines learner progress and demonstrates understanding of the curriculum (Joshi et al., 2020). Compared to traditional assessments conducted in brick-and-mortar classrooms, the digital assessment approach provides a set of benefits to all stakeholders in the ecosystem. Digital assessment systems should, however, be cognisant of the educational goals and should support learners to develop skills useful in the world of work for lifelong learning.

Technologies such as AI play a vital role in transforming the education ecosystem. Open AI technologies such as ChatGPT are promising to improve the education system, thus digital assessments. However, they pose a threat if not ethically used. Beyond technology are user-based and infrastructural challenges that have to be overcome for digital assessments to be optimised. The challenges have been profiled and a best practices model is presented to guide adoption and utilisation. Future work points to the validation of the developed model. The Ministry of Education and Sports (MoES) (2020) suggests

the need for a deliberate Digital Agenda Strategy (DAS) to guide sustainable adoption, implementation, monitoring and evaluation, measuring and reporting on ICTs in education in the country. This study contributed to this vision through the developed best practices model.

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References

A. Bassey, B., O. Ubi, I., E. Anagbougu, G., & J. Owan, V. (2020). Permutation of UTME multiple-choice test items on performance in use of English and mathematics among prospective higher education students. *The Journal of Social Sciences Research*, *6*(64), 483–493. https://doi.org/10.32861/jssr.64.483.493

A guide to delivering digital assessment with online proctoring. (n.d.). www.proctorexam.com

Agency, A. D. (2011). *Manual capacity development*. Stockholm: Sida. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Manual+Capacity+Development#4

Ahmed, S. (2022). Nature, scope, and objectives of education management. *Research Gate*, *July*, 1–9.

Aier, S., & Gleichauf, B. (2010). Applying design research artefacts for building design research artefacts: A process model for enterprise architecture planning. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *6105 LNCS*, 333–348. https://doi.org/10.1007/978-3-642-13335-0_23

Almusaed, A., Almssad, A., Yitmen, I., & Homod, R. Z. (2023). Enhancing student engagement: Harnessing "AIED"'s power in hybrid education – A review analysis. *Education Sciences*, *13*(7), 632. https://doi.org/10.3390/educsci13070632

Alyahya, D., & Almutairi, N. (2019). The impact of electronic tests on students' performance assessment. *International Education Studies*, *12*(5), 109. https://doi.org/10.5539/ies.v12n5p109

Andrejevic, M., & Selwyn, N. (2020). Facial recognition technology in schools: Critical questions and concerns. *Learning, Media and Technology*, *45*(2), 115–128. https://doi.org/10.1080/17439884.2020.1686014

Appiah, M., & van Tonder, F. (2018). E-assessment in higher education: A review. *International Journal of Business Management and Economic Research*, *9*(6), 1454–1460. www.ijbmer.com

Arnott, D., & Pervan, G. (2012). Design science in decision support systems research: An assessment using the Hevner, March, Park, and Ram guidelines. *Journal of the Association for Information Systems*, *13*(11), 923–949. https://doi.org/10.17705/1jais.00315

Aruleba, K., Jere, N., & Matarirano, O. (2022). Technology adoption readiness in disadvantaged universities during COVID-19 pandemic in South Africa. *International Journal of Higher Education*, *11*(2), 172. https://doi.org/10.5430/ijhe.v11n2p172

Asian Development Bank. (2009). *Good practice in information and communication technology for education*. 1–26. www.adb.org

Assessments, C. D. (n.d.). *Common core and more 10 steps to a successful digital readiness assessment stakeholder engagement*.

Bariu, T. N. (2020). Status of ICT infrastructure used in teaching and learning in secondary schools in Meru County, Kenya. *European Journal of Interactive Multimedia and Education*, *1*(1), e02002. https://doi.org/10.30935/ejimed/8283

Başak, M., & Ayvacı, H. (2017). A comparison is aimed at the integration of the technology in education system; as an example of "Turkey and South Korea." *TED EĞİTİM VE BİLİM*. https://doi.org/10.15390/EB.2017.6710

Basar, Z. M., Mansor, A. N., Jamaludin, K. A., & Alias, B. S. (2021). The effectiveness and challenges of online learning for secondary school students – A case study. *Asian Journal of University Education*, *17*(3), 119–129. https://doi.org/10.24191/ajue.v17i3.14514

Begnum, M. E. N., & Foss-Pedersen, R. J. (2018a). Digital assessment in higher education: Promoting universal usability through requirements specification and universal design quality (UD-Q) reviews. *Universal Access in the Information Society*, *17*(4), 791–810. https://doi.org/10.1007/s10209-016-0513-9

Begnum, M. E. N., & Foss-Pedersen, R. J. (2018b). Digital assessment in higher education. *Universal Access in the Information Society*, *17*(4), 791–810. https://doi.org/10.1007/s10209-016-0513-9

Beleulmi, S. (2022). *Challenges of online assessment during Covid-19 pandemic: An experience of Study Skills teachers*. *April*.

Benefits of online assessment test over the offline assessment test – Hurix. (n.d.).

Board, E., & Programme, H. S. (2020). *Executive Board of the United Nations Human Settlements Programme*. 1–11.

Boucher, P. (2020). Artificial intelligence: How does it work, why does it matter, and what can we do about it? In *Scientific Foresight Unit, European Parliamentary Research Service* (Issue June). https://www.europarl.europa.eu/RegData/etudes/STUD/2020/641547/EPRS_STU(2020)641547_EN.pdf

Bourdeaux, M. (1981). Letter from the Director. *Religion in Communist Lands*, *9*(1), 2–3. https://doi.org/10.1080/09637498108430973

Brunnquell, C., & Brunstein, J. (2018). Sustainability in management education: Contributions from critical reflection and transformative learning. *Metropolitan Universities*, *29*(3). https://doi.org/10.18060/21466

Charles, D. O. N. C. (1976). Overview of educational psychology. *Psychology*, *88*(10), 76–88.

Chatterjee, J., & Dethlefs, N. (2023). This new conversational AI model can be your friend, philosopher, and guide. and even your worst enemy. *Patterns*, *4*(1), 100676. https://doi.org/10.1016/j.patter.2022.100676

Chufama, M. (2021). The pivotal role of diagnostic, formative and summative assessment in higher education institutions' teaching and student learning. *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, *4*(5), 5–15. http://ijmrap.com/wp-content/uploads/2021/10/IJMRAP-V4N4P107Y21.pdf

Coalition, D. U. S. (2020). *Building a digitally resilient workforce: creating on-ramps to opportunity*. *May*.

Cumhur, F., & Çam, Ş. S. (2021). Digital transformation in assessment and evaluation course: The effects of Web 2.0 tools. *Journal of Pedagogical Research*, *5*(3), 15–39. https://doi.org/10.33902/JPR.2021370559

Dancsa, D., Štempeľová, I., Takáč, O., & Annuš, N. (2023). Digital tools in education. *International Journal of Advanced Natural Sciences and Engineering Researches*, *7*(4), 289–294. https://doi.org/10.59287/ijanser.717

Dawani, S. (2023). *Integrating artificial intelligence into creativity education: Developing a creative problem-solving course for higher education*. https://digitalcommons.buffalostate.edu/creativeprojects/363/%0Ahttps://digitalcommons.buffalostate.edu/cgi/viewcontent.cgi?article=1375&context=creativeprojects

DeLauri, A. (2020). Humanitarianism: Keywords. *Humanitarianism: Keywords*, 16–18. https://doi.org/10.1163/9789004431140

Deng, C., Ji, X., Rainey, C., Zhang, J., & Lu, W. (2020). Integrating machine learning with human knowledge. *IScience*, *23*(11), 101656. https://doi.org/10.1016/j.isci.2020.101656

Devi, D., & Rroy, A. D. (2023). Role of artificial intelligence (AI) in sustainable education of higher education institutions in Guwahati City: Teachers' perception. *International Management Review*, *19* (Special Issue), 111–116. http://www.americanscholarspress.us/journals/IMR/pdf/IMR-0-2023/IMR2023SpringSp-art10.pdf

Dhara, S., Chatterjee, S., Chaudhuri, R., Goswami, A., & Ghosh, S. K. (2022). Artificial intelligence in assessment of students' performance. *Artificial Intelligence in Higher Education*, *July*, 153–167. https://doi.org/10.1201/9781003184157-8

Elliott, D., & Soifer, E. (2022). AI technologies, privacy, and security. *Frontiers in Artificial Intelligence*, *5*(April), 1–8. https://doi.org/10.3389/frai.2022.826737

ElSaheli-Elhage, R. (2020). Access to students and parents and levels of preparedness of educators during the COVID-19 emergency transition to e-learning. *International Journal on Studies in Education*, *3*(2), 61–69. https://doi.org/10.46328/ijonse.35

Elsalem, L., Al-Azzam, N., Jum'ah, A. A., & Obeidat, N. (2021). Remote e-exams during Covid-19 pandemic: A cross-sectional study of students' preferences and academic dishonesty in faculties of medical sciences. *Annals of Medicine and Surgery*, *62*(January), 326–333. https://doi.org/10.1016/j.amsu.2021.01.054

Full Integration of Digital Assessment. (n.d.).

Gammelgaard Nielsen, K., & Petersen, L. (2013). Digital assessments. In *EUNIS 2013 Congress Proceedings: 2013: ICT Role for Next Generation Universities* (Vol. 1, Issue 1). https://doi.org/10.7250/eunis.2013.016

Gezer, T., Wang, C., Polly, A., Martin, C., Pugalee, D., & Lambert, R. (2021). The relationship between formative assessment and summative assessment in primary grade mathematics classrooms*. *International Electronic Journal of Elementary Education*, *13*(5), 673–685. https://doi.org/10.26822/iejee.2021.220

Ghazal, S., Al-Samarraie, H., & Aldowah, H. (2018). "i am Still Learning": Modeling LMS critical success factors for promoting students' experience and satisfaction in a blended learning environment. *IEEE Access*, *6*, 77179–77201. https://doi.org/10.1109/ACCESS.2018.2879677

GLANCE, A. T. A. (n.d.). Digital resilience in the American workforce. *Butlercc.Edu*. https://www.butlercc.edu/download/downloads/id/1628/digital-literacy-in-the-american-workforce.pdf

Gupta, M. M., Jankie, S., Pancholi, S. S., Talukdar, D., Sahu, P. K., & Sa, B. (2020). Asynchronous environment assessment: A pertinent option for medical and allied health profession education during the Covid-19 pandemic. *Education Sciences*, *10*(12), 1–14. https://doi.org/10.3390/educsci10120352

Halaweh, M. (2023). ChatGPT in education: Strategies for responsible implementation. *Contemporary Educational Technology*, *15*(2). https://doi.org/10.30935/cedtech/13036

Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems*, *19*(2), 87–92.

Hevner, A. R., Florida, S., & March, S. T. (1996). *Cycle*. 111–113.

Hevner, A. R., March, S. T., Park, J., Ram, S., & Ram, S. (2004). Research essay design science in information. *MIS Quarterly*, *28*(1), 75–105.

Holden, O. L., Norris, M. E., & Kuhlmeier, V. A. (2021). Academic integrity in online assessment: A research review. *Frontiers in Education*, *6*(July), 1–13. https://doi.org/10.3389/feduc.2021.639814

Holfelder, A. K. (2019). Towards a sustainable future with education? *Sustainability Science*, *14*(4), 943–952. https://doi.org/10.1007/s11625-019-00682-z

Hooda, M., Rana, C., Dahiya, O., Rizwan, A., & Hossain, M. S. (2022). Artificial intelligence for assessment and feedback to enhance student success in higher education. *Mathematical Problems in Engineering*, *2022*, 5215722. https://doi.org/10.1155/2022/5215722

Huda, S. S. M., & Siddiq, T. (2020). E-assessment in higher education: Students' perspective. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, *16*(2), 250–258.

Hussein, M. J., Yusuf, J., Deb, A. S., Fong, L., & Naidu, S. (2020). An evaluation of online proctoring tools. *Open Praxis*, *12*(4), 509. https://doi.org/10.5944/openpraxis.12.4.1113

Ikechukwu, A. (2020). *Cognitive test anxiety and examination malpractices among senior secondary school students in Rivers State*. *July*.

Jaiswal, A., & Arun, C. J. (2021). Potential of artificial intelligence for transformation of the education system in India. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, *17*(1), 142–158.

Javaid, M., Haleem, A., Singh, R. P., Khan, S., & Khan, I. H. (2023). Unlocking the opportunities through ChatGPT tool towards ameliorating the education system. *Bench Council Transactions on Benchmarks, Standards and Evaluations*, *3*(2), 100115. https://doi.org/10.1016/j.tbench.2023.100115

JICA. (2003). *Capacity development and JICA's activities*. February. http://jica-ri.jica.go.jp/IFIC_and_JBICI-Studies/english/publications/reports/study/capacity/200302/pdf/200302_01.pdf

Johnston, R. B. (2016). Arsenic and the 2030 Agenda for sustainable development. *Arsenic Research and Global Sustainability – Proceedings of the 6th International Congress on Arsenic in the Environment, AS 2016*, 12–14. https://doi.org/10.1201/b20466-7

Kelly, S., Kaye, S. A., & Oviedo-Trespalacios, O. (2023). What factors contribute to the acceptance of artificial intelligence? A systematic review. *Telematics and Informatics*, *77*(December 2022), 101925. https://doi.org/10.1016/j.tele.2022.101925

Khan, M. A., Vivek, V., Khojah, M., Nabi, M. K., Paul, M., & Minhaj, S. M. (2021). Learners' perspective towards e-exams during Covid-19 outbreak: Evidence from higher educational institutions of India and Saudi Arabia. *International Journal of Environmental Research and Public Health*, *18*(12). https://doi.org/10.3390/ijerph18126534

King, M. R. (2023). A conversation on artificial intelligence, chatbots, and plagiarism in higher education. *Cellular and Molecular Bioengineering*, *16*(1), 1–2. https://doi.org/10.1007/s12195-022-00754-8

Klinger, D., & Trask, S. (2020). *NCEA online research: More than one digital NCEA external assessment opportunity per annum*. Final report. August.

Kohn, V. (2023). Operationalising digital resilience – A systematic literature review on opportunities and challenges. *Proceedings of the Annual Hawaii International Conference on System Sciences*, *2023-January*, 6431–6441.

Levin, D., Fletcher, G., & Chau, Y. (2011). *Technology requirements for large-scale computer-based and online assessment: Current status and issues*. 44.

Luckin, R. (2017). Towards artificial intelligence-based assessment systems. *Nature Human Behaviour*, *1*(3). https://doi.org/10.1038/s41562-016-0028

Lynch, R., Asavisanu, P., Rungrojngarmcharoen, K., & Ye, Y. (2020). *Educational management*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190264093.013.701

Mahlangu, G., & Makwasha, L. (2023). Factors affecting the adoption and use of online assessment for learning at polytechnics in Zimbabwe. *Cogent Education*, *10*(1). https://doi.org/10.1080/2331186X.2023.2177475

Marrone, R., Taddeo, V., & Hill, G. (2022). Creativity and artificial intelligence – A student perspective. *Journal of Intelligence*, *10*(3), 1–11. https://doi.org/10.3390/jintelligence10030065

Ministero dell'Economia e delle Finanze. (2020). 18/2020 (Art 3, 4 E 18). *Gazzetta Ufficiale Della Repubblica Italiana, No. 70*.

Ministry of Education and Sports (MoES). (2020). *Digital agenda for the education and sports sector. July*. https://www.education.go.ug/wp-content/uploads/2021/08/MoESDraft-Concept-Note-Digital-Agenda-MoES-2020-07-22_version13-Final.pdf

Mitrofanova, E. A., Mitrofanova, A. E., & Zaharov, D. K. (2020). *The assessment of the university preparedness for digital technologies implementation*. 382–390. https://doi.org/10.15405/epsbs.2020.04.49

Moore, J. E., Mascarenhas, A., Bain, J., & Straus, S. E. (2017). Developing a comprehensive definition of sustainability. *Implementation Science*, *12*(1), 1–9. https://doi.org/10.1186/s13012-017-0637-1

N, E., Yeon, G., Perumbilly, S., & Awungshi, S. H. (2021). Transitional challenges in technology adoption among academic communities in Indian higher education institutions. *Journal of International Technology and Information Management*, *30*(2), 59–96. https://doi.org/10.58729/1941-6679.1494

National Planning Authority. (2020). Third National Development Plan (NDPIII) 2020/21-2024/25. *National Planning Authority*, *January*, 1–310.

Natumanya, D., Nabaasa, E., Pius, D., & American, A. (2021). Usage and security of examination modes of assessment: A survey of two universities in south western Uganda. *Journal of Online and Distance Learning*, *3*, 25–36. www.ajpojournals.org

Nazaretsky, T., Ariely, M., Cukurova, M., & Alexandron, G. (2022). Teachers' trust in AI-powered educational technology and a professional development program to improve it. *British Journal of Educational Technology*, *53*(4), 914–931. https://doi.org/10.1111/bjet.13232

NCHE. (2019). *National Council for Higher Education minimum standards for open distance and e-learning. August*, 0–18. https://unche.or.ug/wp-content/uploads/2021/09/ODeL-Minimum-Standards_Final_2019.pdf

NCHE. (2020a). National Council for Higher Education guidelines for adoption of an emergency open, distance and e-learning (OdeL) system by the higher education institutions during the Covid-19 lockdown. National Council for Higer Education, June, 1–50.

NCHE. (2020b). *Strategic plan 2020/2021–2024/2025*.

Ngqondi, T., Maoneke, P. B., & Mauwa, H. (2021). A secure online exams conceptual framework for South African universities. *Social Sciences and Humanities Open*, *3*(1), 100132. https://doi.org/10.1016/j.ssaho.2021.100132

O'Toole, L. J. (2019). Institutional capacity and development. *Institutions, Policy and Outputs for Acidification*, 76–84. https://doi.org/10.4324/9780429452253-8

OECD. (2016). *Innovating education and educating for innovation: The power of digital technologies and skills*. https://doi.org/10.1787/9789264265097-en

Oldfield, A., Broadfoot, P., Sutherland, R., & Timmis, S. (2012). Assessment in a digital age: A research review. *Technology Enhanced Assessment: Review of the Literature*, 1–40. http://www.bristol.ac.uk/media-library/sites/education/documents/researchreview.pdf

Orsi Koch Delgado, H., De Azevedo Fay, A., Sebastiany, M. J., & Cortina Silva, A. D. (2020). Artificial intelligence adaptive learning tools. *BELT–Brazilian English Language Teaching Journal*, *11*(2), e38749. https://doi.org/10.15448/2178-3640.2020.2.38749

Osuji, U. S. A. (2012). The use of e-assessments in the Nigerian higher education system. *The Turkish Online Journal of Distance Education*, *13*, 140–152. https://api.semanticscholar.org/CorpusID:62168954

Owan, V. J., Abang, K. B., Idika, D. O., Etta, E. O., & Bassey, B. A. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(8), em2307. https://doi.org/10.29333/ejmste/13428

Owayjan, M., Dergham, A., Haber, G., Fakih, N., Hamoush, A., & Abdo, E. (2015). Face recognition security system. *Lecture Notes in Electrical Engineering*, *312*(April), 343–348. https://doi.org/10.1007/978-3-319-06764-3_42

Peffers, K, Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Peffers, Ken, Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2014). *A design science research methodology for information systems research*. *1222*. https://doi.org/10.2753/MIS0742-1222240302

Raaheim, A., Mathiassen, K., Moen, V., Lona, I., Gynnild, V., Bunæs, B. R., & Hasle, E. T. (2019). Digital assessment–how does it challenge local practices and national law? A Norwegian case study. *European Journal of Higher Education*, *9*(2), 219–231. https://doi.org/10.1080/21568235.2018.1541420

Saura, J. R., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2022). Assessing behavioral data science privacy issues in government artificial intelligence deployment. *Government Information Quarterly*, *39*(4). https://doi.org/10.1016/j.giq.2022.101679

Schleicher, A. (2020). The impact of COVID-19 on education: Insights from education at a glance 2020. *OECD Journal: Economic Studies*, 1–31. https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf

Sharma, R. C. (2021). *Application of artificial intelligence in education*. *October*. https://www.researchgate.net/publication/355035239_Applications_of_Artificial_Intelligence_in_Education

Sterling, S. (2009). Sustainable education. *Science Society and Sustainability*, *May*, 105–118. https://doi.org/10.4324/9780203875124

Sukmandhani, A. A., & Sutedja, I. (2019). Face recognition method for online exams. *Proceedings of 2019 International Conference on Information Management and Technology, ICIMTech 2019*, *1*(August 2019), 175–179. https://doi.org/10.1109/ICIMTech.2019.8843831

Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J. M., Milligan, S., Selwyn, N., & Gašević, D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence*, *3*(May). https://doi.org/10.1016/j.caeai.2022.100075

Teslia, I., Yehorchenkova, N., Khlevna, I., Kataieva, Y., Latysheva, T., Yehorchenkov, O., Khlevnyi, A., & Veretelnyk, V. (2020). Developing a systems engineering concept for digitalizing higher education institutions. *Eastern-European Journal of Enterprise Technologies*, *6*(2–108), 6–20. https://doi.org/10.15587/1729-4061.2020.219260

Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). *Rethinking Assessment in a Digital Age: Opportunities, Challenges and Risks*. *42*(3), 454–476. https://doi.org/10.1002/berj.3215

Tira Nur Fitria. (2021). Artificial intelligence (AI) in education: Using AI tools for teaching and learning process. *Proceeding Seminar Nasional & Call for Papers Surakarta*, *December*, 189–200.

Tovani-Palone, M. R. (2023). Some challenges and limitations of using ChatGPT in medicine. *Electronic Journal of General Medicine*, *20*(5), 36964339. https://doi.org/10.29333/ejgm/13263

U.S. Department of Education. (2017). *Building technology infrastructure for learning*. *June*, 75. https://tech.ed.gov

UNDG. (2017). *Capacity development UNDAF companion guidance*. *June*, 1–20. https://unsdg.un.org/resources/capacity-development-undaf-companion-guidance

UNESCO Digital Library. (2019). Artificial intelligence for sustainable development: Synthesis report, Mobile Learning Week 2019 – UNESCO Biblioteca Digital. *Biblioteca Digital UNESDOC*, *August 2022*, 11–45. https://unesdoc.unesco.org/ark:/48223/pf0000370308

United Nations, International Institute for Sustainable Development. (2016). UN Sustainable Development Goals; 2030 Agenda for Sustainable Development. *Journal for International Institute for Sustainable Development*, *1*(1), 1–35.

Valdez, M. T. C. C., & Maderal, L. D. (2021). An analysis of students' perception of online assessments and its relation to motivation towards mathematics learning. *Electronic Journal of E-Learning*, *19*(5), 416–431. https://doi.org/10.34190/ejel.19.5.2481

Verhoef, A. H., & Coetser, Y. M. (2021). Academic integrity of university students during emergency remote online assessment: An exploration of student voices. *Transformation in Higher Education*, *6*(September), 0–12. https://doi.org/10.4102/THE.V6I0.132

Zamfir, I. (2017). Understanding capacity-building/ capacity development: A core concept of development policy. *European Parliamentary Research Service*, *April*, 1–8. https://www.europarl.europa.eu/thinktank/en/document.html?reference=EPRS_BRI(2017)599411

Zamrodah, Y. (2016). *Ethics and integrity in the changing world*. *15*(2), 1–23.

Zhong, Y., & Liu, H. (2010). A research methodology for green IT systems based on WSR and design science: The case of a Chinese company. *Communications in Computer and Information Science*, *113 CCIS*, 215–225. https://doi.org/10.1007/978-3-642-16397-5_19