Framework for Full Integration of ICT in Assessment in Secondary Schools in Tanzania

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Abstract

In the rapidly evolving landscape of education, Information and Communication Technology (ICT) has emerged as a vital tool for enhancing teaching and learning processes. Various frameworks have been designed globally to integrate e-assessment in secondary schools. However, several studies indicate limited integration of ICT in assessment in secondary schools in Tanzania. Therefore, this study aimed to establish a framework for the full integration of ICT in assessment in secondary schools. The study adopted a qualitative research approach, and the data was collected through focus group discussion and interviews with 200 students and 50 teachers drawn from 10 secondary schools in Tanzania who were sampled through purposive sampling techniques. The study explores the content, purpose, use and effectiveness of the e-assessment using thematic coding analysis. The study established that e-assessment is beneficial and effective, yet it has not been fully integrated and adopted in secondary schools. Although some schools use ICT in teaching and learning and to some extent in the analysing of students' scores, the e-assessment which involves ICT in all assessment stages has not been realised. The study recommended that full adoption and use of e-assessment can be enhanced by the integration of e-learning in the secondary syllabus. Therefore, the government should ensure that e-assessment facilitating conditions are met.

Keywords: *Assessment, e-assessment, Frameworks, Integration, Technology*

Introduction

Teaching and learning processes cannot be completed without undertaking an assessment to determine the learner's achievement and instructional effectiveness (NECTA, 2021; Bashitialshaaer et al., 2021). Assessments in schools have been mainly pencil-paper based despite the call to fully

integrate Information Communication and Technology (ICT) or Education Technology (EduTech) in teaching and learning processes. However, during the outbreak of the Covid-19 pandemic, face-to-face learning programs were suspended in all schools, learning activities were halted and disrupted, and only e-learning could mediate the situation (Chakraborty et al., 2021; Das et al., 2022; Manyilizu, 2023a; Manyilizu, 2023b). Nevertheless, no learning institution was ready for a complete shift to e-learning because they could not apply ICT in all stages of learning (lesson preparation, presentation or delivery, and assessment), especially in assessment (Mchalo et al., 2021). Complete e-learning cannot be realized without e-assessment, which entails the use of technology to mediate any part of the assessment process, such as test items preparation, delivery, analysing and reporting (Burr et al., 2016). Therefore, e-assessment can be both computer-based assessment (CBA), in which technology is used to assess the learning process and computer-assisted assessment (CAA), in which the technology is used to help in the submission of coursework.

According to Swaffield (2011), e-assessment is the use of ICTs to modernize every aspect of assessment, from creating and distributing assignments to marking them (either automatically or with the aid of digital tools), reporting, storing the results and/or performing statistical analysis). Electronic assessment (e-assessment) was designed to solve and overcome challenges associated with traditional assessment (Huda & Siddiq, 2020). Some of the benefits of e-assessment over a pencil-and-paper include but are not limited to: First, openness and flexibility in which it does not need the physical presence of learners and teachers (Elsalem et al., 2021 & Yong et al., 2021). Second, it enables immediate, direct and specific feedback, auto-grading, and automated record-keeping, hence can serve a large number of students in a short period (Mate & Weidenhofer, 2022; Shakeel et al., 2021). Third, it enhances fairness by reducing human interference during the assessment process exams and shortening time spent in preparation and managing the assessment period (Elsalem et al., 2021; Yong et al., 2021 & Rayan et al., 2021). Generally, it is stated that e-assessment is more effective and efficient if appropriately applied (Ali et al., 2021; Iskandar et al., 2021; Mate & Weidenhofer, 2022).

Ngqondi et al. (2021) observed that, although blended learning has facilitated e-assessment in formative assessment in assignments distributions or project submission and quizzes, little progress has been made in adopting and using e-assessment in summative assessments (Apampa et al., 2010; Draaijer et al., 2018; UNESCO, 2020). The main challenge in adopting and using e-assessment has been reported to be academic fraud in terms of academic dishonesty and identity misrepresentation, which can easily jeopardise the

institutional integrity and the credibility of assessment (Barnes & Paris, 2013; McGee, 2013; Paullet et al., 2014).

The debate on academic fraud being more in e-assessment compared to traditional learning is because traditional pencil-paper based is done under the invigilator, while in e-assessment, students work independently with little or no formal invigilator (Barnes & Paris, 2013; King et al., 2009; McGee, 2013). In this regard, any institution offering e-learning with e-assessment should have the policy to ensure the integrity of the student's work and the credibility of qualifications, degrees and credits (Barnes & Paris, 2013; McGee, 2013). The US government policy requires that any learning institution with e-examination must implement measures for promoting academic honesty; otherwise, they risk revocation of their accreditation. Summative e-assessment is being used in universities and private sectors. Nevertheless, the e-assessment remains new and unknown in the European Union and Belgian universities being the earlier adopters (Draaijer et al., 2018). According to the literature reviewed so far, no country has conducted an e-summative national assessment for secondary schools, and little is known on this in terms of its adoption, implementation and evaluation; the literature is basically for tertiary-level education.

There are various e-assessment platforms which are in place, and some of them include Quizlet, Socrates, iSpring Suite, Google Forms, Microsoft Forms and Qorrect (Cavus & Mohammed, 2021; Grönlund et al., 2021; Kant et al., 2021 & Steindal et al., 2021). Additionally, some of the widely used activities in e-assessment are e-essay and computer-marked exams (Theresa et al., 2021). Nevertheless, the successful adoption and use of e-assessment has been challenging and minimal; many studies conducted on it have focused on learning management systems, leading to inadequate knowledge on how to adopt and use e-assessment (Ahmed & Mesonovich, 2019; Alturki, 2021; Cavus & Mohammed, 2021; Grönlund et al., 2021; Kant et al., 2021; Steindal et al., 2021). Some few studies were carried out on the adoption of e-assessment during Covid-19. They include the adoption of e-examination (Yong et al., 2021), transitioning to e-assessment (Mate & Weidenhofer, 2022), effective and authentic e-assessment tools (Butler-henderson & Crawford, 2020), propose e-examination adoption framework (Ngqondi et al., 2021), and student's attitudes towards e-examinations (Reedy et al., 2021).

The government of Tanzania and some organisations are making significant investments in ICT to be utilised in teaching and learning in secondary schools. This is carried out through policy formulation, implementation and initiatives, ICT infrastructural development and staff training to gain the

benefits that ICT offers (Banele, 2019; Manyilizu, 2023a; Manyilizu, 2023b). However, until recently, the e-assessment has not been fully integrated into the learning system in secondary schools in Tanzania; neither CBA nor CAA is in place, and no framework for e-assessment been established (Daudi & Nzilamo, 2019; Mchalo et al. 2021 & Kuboja, 2019). Therefore, this study establishes an e-assessment framework for Tanzanian secondary schools. To achieve the main objective, the study addressed the following three specific objectives;

i) To conduct situational analysis for e-assessment frameworks in relation to Tanzanian secondary schools.
ii) To determine factors for the e-assessment framework in the context of Tanzanian secondary schools.
iii) To devise a suitable framework for e-assessment in secondary schools in Tanzania.

This study provides significant contributions to educational technology and policymaking by supporting efforts to digitalize learning. Education technology supports the digital education environment, as witnessed during the COVID-19 pandemic when it facilitated continuous teaching and learning.

Electronic Assessment

Electronic assessment (e-assessment) is a systematic, continuous process of monitoring various learning pieces to evaluate learners' achievement and instructional effectiveness using ICT (Ally, 2024; NECTA, 2021). It also refers to electronic activities (e-activities) and programmes that are designed to measure learners' achievement from an instructional programme. This study focuses on the e-assessment for the evaluation of learner's achievement and instructional effectiveness as opposed to e-activities designed to measure the achievement and instructional effectiveness. There are three main types of e-assessment: diagnostic, formative and summative assessments (Ally, 2024; Huda & Siddiq, 2020). Diagnostic e-assessment is carried out prior to instruction, and it helps the teachers to know learners' individual strengths, weaknesses, and knowledge using ICT before a lesson or instruction. Formative e-assessment is conducted with ICT during the learning process to determine whether the learner can do what he or she could not do before learning. A summative e-assessment is conducted at the end of an educational activity using ICT to provide feedback that summarises the teaching and learning process at a particular level. In order to realise a full e-assessment, ICT should be fully integrated in all stages of assessment, from preparation of items, delivery, analysis and reporting of assessment (Ally, 2024; Elsalem et al., 2021).

Electronic Assessment Framework

A framework for electronic assessment (e-assessment) is expected to cover all the stages of assessment, such as preparation of test items, delivery of the tests, analysis or marking of the tests, and reporting or giving feedback (Langenfeld et al., 2022; Swaffield, 2011). The distinction between e-assessment, blended assessment and assessment frameworks is that e-assessment fully integrates the use of ICT in all the stages of assessment. Nevertheless, the barriers facing the full integration of ICT in the assessment include poor ICT infrastructure and readiness (Ally, 2024). Figure 1 below illustrates the summative e-assessment life cycle from preparation to the reporting stage.

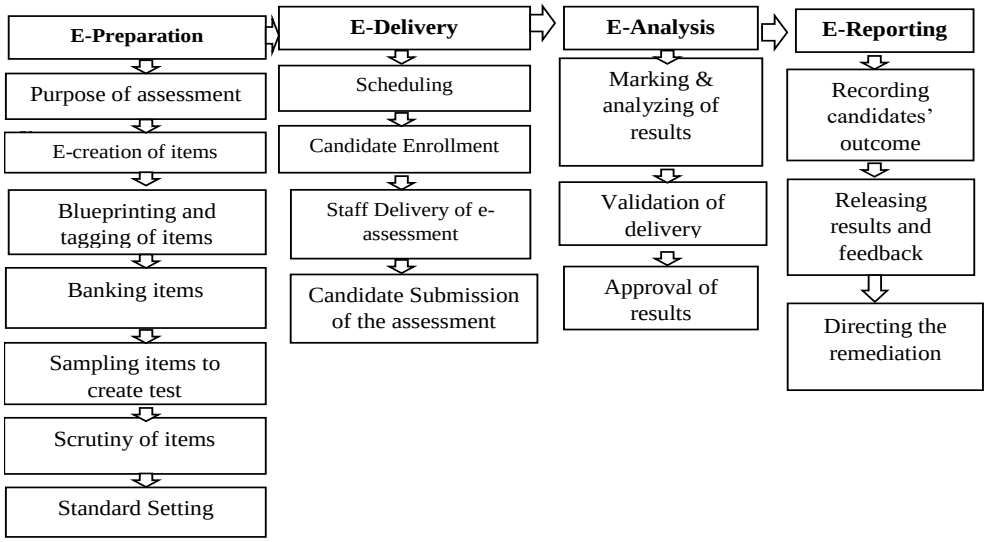

Figure 1: Summative e-assement life cycte as adopted from Burr et. (2016)

Figure 1 demonstrates the e-assessment life cycle that learners and teachers must follow while undertaking e-assessment. The cycle has four major stages: e-preparation, e-delivery, e-analysis, and e-reporting or e-relay of the feedback. The summative assessment in secondary schools in Tanzania by NECTA for (forms two, four, and six) has to follow the e-assessment cycle for it to be regarded as an e-assessment. Each phase in the e-assemenet cycle is detailed below:

E-Preparation or Assessment Generation stage

Teachers or test setters prepare tables of specification by considering learnt areas or content covered in the syllabus. From the specification table, test items or questions are constructed depending on their weight or time spent. The test items are then moderated and reviewed to make them more valid and reliable. The test items or e-assessment is then ready and stored or banked to

await delivery. During the e-preparation, the setter or examiner can fully adopt an ICT system- software program (e.g., Quizlet, Socrates, or iSpring Suite) with the syllabus, which can be automated to generate test specification tables and sample test items. The software can proofread the test items if the correct wording is used in line with the syllabus to ensure the validity and reliability of the test. The software should also be secured and free from threats and infiltration by unauthorized users.

Indeed, the advent of ICT/EduTech into assessment replaced human (human item writers) uses in constructing test items. The use of human item writers had many inaccuracies or errors in the assessment items. The use of ICT introduced the use of item engines (enhanced by artificial intelligence technologies) to construct and develop assessment items (PTC, 2002). The item engines (e.g., Computer-Adaptive Tests) are efficient in producing assessment items and help to ensure the consistency and quality of assessment items produced.

E-assessment Delivery Stage

The e-assessment delivery stage deals with the e-administration and e-delivery of CBA to the students who are to be assessed (PTC, 2002). Test items, exams or assessments are shared with the learners in order to make them give their responses. Currently, exams that NECTA sets are transported from the examination setting headquarters and delivered to the schools. On the examination date, students in their respective schools or examination centres are issued the examination papers by the invigilators, and they follow written instructions as answer they answer examination questions for various subjects. At the end of the examination, the answered scripts are taken back to the examination headquarters for pool marking. This process is tiresome and time-consuming, less secured and is likely to expose test items to unauthorised persons, hence encouraging examination leakage. There are various e-assessment delivery models that will be discussed such as computer adaptive tests. The component is developed on a web-based technology that involves communication between a central server and several remote computers connected to a computer network. It also involves the delivery of assessments using webpage interfaces (Van Vuuren et al., 2013). The system enables examiners and coordinators to assess the students regardless of location (PTC, 2002).

E-assessment Analysis Stage

This stage involves scoring and interpretation of the submitted assessment. The students' scripts are marked by the national markers, who count and record the marks in the scripts manually. The recorded marks or scores are keyed in the appropriate software for further analysis. The analysis takes

more time when not assisted by computers. To electronicize this stage, the e-assessment delivery model should be used, and the students' responses should be shared directly with the examiners with the help of a software program. Correspondingly, the scoring or marking can be automated, followed by auto-grading, and automated record-keeping. The pencil-paper-based method was time-consuming and error-prone, especially when complex calculations were involved (PTC, 2002). However, with the help of ICT, scoring and interpretation of the assessment are becoming instant. Software packages, such as pattern recognition software and Computer Based Test Interpretation (CBTI) software are examples of software packages that can be used for assessment scoring and interpretation, respectively, in a CBA (PTC, 2002; van Vuuren et al., 2013).

E-assessment Reporting stage

E-assessment reporting stage involves e-storage, e-retrieval and transmission, which involves relying on or giving the students feedback on their performance. NECTA normally gives the feedback to schools or examination centres, and the students can also access this remotely. With pure e-analysis of the students' results and auto-grading, quick feedback can be given to the examinees. In e-assessment, the system consists of a database management system (DBMS) used for storing, retrieving and transmitting data (PTC, 2002; van Vuuren et al., 2013). The data comprises assessment items that have been created, delivered, scored and interpreted by the other components of the CBA system. The DBMS required by e-assessment often depends on the amount of data set available to be stored. If a CBA system is designed to serve many students, then a commercial database management system, like Oracle or MySQL, may be required (PTC, 2002; van Vuuren et al., 2013).

E-assessment Delivery Models

There are different e-assessment delivery models that have been designed and implemented. This study only reviews three of them, from which an e-assessment framework will be used in the Tanzania context. The models are reviewed in respect to their use of adaptive algorithms, the size of the test administration units, and the nature and extent to which automated test assembly is used (Luecht & Sireci, 2011).

Computerised fixed-test or preassembled parallel

Computerised fixed-test or preassembled parallel is a reconstructed, intact test form that is administered by computer to large numbers of students. Different examinees may see different test forms, but all examinees administered the same form will see exactly the same items (Parshall et al., 2002). In the typical implementation of this model, several or many test forms of the same fixed length are available for administration, and one is

randomly selected for each examinee. The model is currently used by Microsoft and other IT certification exam agencies, Physical Therapist, and Physical Therapist Assistant licensure exams. The model's strength is that it allows a review of test forms before administration, and the examinees can skip and change answers to items, with no item selection algorithm needed. However, the limitation of the model is that there is no improvement in measurement efficiency. It has inefficient use of item pool and poor control of item exposure in case of few forms.

Computer-adaptive tests

Computer-Adaptive Tests (CAT) adapts or tailors the exam to each examinee (Davey & Pitoniak, 2006 & van der Linden, 2010). Under the purest form of CAT, this tailoring is done by keeping track of an examinee's performance on each test item and then selecting the following item to be administered (Wainer et al., 2000). Thus, CATs are sequentially developed item-by-item in real-time by the test-delivery software. The criteria for selecting the next item to be administered to an examinee can range from simply choosing items that maximise the reliability of each examinee's score to complex. The model is currently used by ACCUPLACER, ASVAB, GRE, Measures of Academic Progress, and Novell. The strength of CAT is its efficiency with respect to measurement precision and a number of items used. The limitation is its content constraints, and item exposure reduces efficiency. Moreover, it requires complex item selection. Test form QA is difficult to implement. Moreover, it requires large item banks. Poor use of the entire item pool, even with exposure controls.

Computer-adaptive multistage testing

Computer-adaptive Multistage Testing (ca-MST) is a framework for managing real-life test construction requirements for large-scale CBT applications (Luecht et al., 1996; Luecht, 2000; Melican et al., 2010; Zenisky et al., 2010). Functionally, ca-MST is a reconstructed, multistage adaptive test model (Luecht et al., 1996). The model uses a manufacturing-engineering paradigm that incorporates multistage adaptive technologies and automated test assembly (ATA) to allow test developers to maintain a greater degree of control over the quality of test forms and data. It can be used for adaptive or mastery testing applications (Breithaupt & Hare, 2007). The modern has been used by NBME (USMLE Field Tests), AICPA (Uniform CPA Examination), ETS (GRE), State of Oregon (ELPA), and Massachusetts Adult Proficiency Tests. The model's strength is due to its reconstructed content-balanced modules with targeted test information and built-in item or module exposure controls. Again, QA of tests is possible. It simplified real-time scoring and routing (score tables). Moreover, its adaptive component improves

measurement precision relative to fixed tests. Nevertheless, the model is less efficient in measurement precision than pure CAT.

The review of the e-assessment delivery models has considered their measurement efficiency, ability to ensure content balance and other test form quality aspects, risk considerations related to data management, item-pool usage, ease of implementation, and performance within large-scale and secure testing networks. In this regard, the choice of a model considers the aforementioned reviewed models have not addressed the whole cycle of e-assessment but only focused on the mode of the delivery of the assessment. As such, without the use of ICT in another stage in the cycle, then the assessment remains as Computer Assisted Assessment (CAA) as opposed to Computer-Based Assessment (CBA).

The Computer Assisted Assessment (CAA) is also undertaken in other countries at different levels. According to the study conducted by Abidin et al. (2019) in Indonesia, 577 grade 11 students from 6 high schools were assessed using Computer Adaptive Test (CAT). The technology adopted was CAT-PhysCriTS; a CAT programme was used to assess students, thinking in Physics via computer. The study from Indonesia established that the test was positive with high precision. Moreover, 98 grade 4 learners in Germany were assessed using a fixed-form test on mathematical competencies via tablets (Blumenthal & Blumenthal, 2020). The test mode was positive, and the test mode effect was negligible. Correspondingly, in the United Kingdom, 159 assessments ware were taken by at least 5,000 students as part of the UK's GCSEs, A Level equivalent. The test was negative with limited reliability, although the studied CATs showed fine results (Benton, 2021). In the cases of Indonesia, Germany, and the United Kingdom, the Computer Assisted Test is not free from challenges or weaknesses such as security threats. Moreover, no country has been established to have a complete e-assessment framework for all students at all levels of education. The majority of the countries have either computer-assisted assessments or pure pencil paper-based assessments.

According to the literature, the use of ICT for teaching and learning is viewed as having numerous advantages over the traditional method if it is optimized, and integrated in all stages of the teaching and learning process. However, the ICT has been minimally used in the assessment of the students, and no country has fully integrated it in the assessment of the students. Although many studies have revealed that ICT is minimally used in assessment in secondary schools and even in Tanzania, there is no established scale for evaluating e-assessment in schools in Tanzania. This is more challenging since e-learning cannot be completed without the e-assessment. Therefore,

the study fills the gap by establishing a scale for evaluating e-assessment in secondary schools in Tanzania.

Facilitating Conditions for E-assessment

Adoption and implementation of e-assessment requires enabling conditions, which other studies term as e-assessment system enablers. Having established a model for e-assessment, critical success factors that are needed include policies, processes, organizational structures, personality traits evaluation and promoting anti-academic fraud attitude, ICT infrastructures, and people's skills and competencies (Ballentine et al.,2019; Huygh et al., 2018).

The enabling factors of e-assessment can also be grounded on the theories, and this borrows from extended Technological, Organizational and Environmental (TOE) framework together with socio-technical theories. The TOE framework holds that in order to adopt and use e-assessment, technological, environmental and environmental factors should be considered. The technological factors include internet access, computing devices and ICT infrastructure. The organisational factor is the institutional support in the form of policies. The environmental factors are academic integrity and individual factors such as digital skills and user perceptions (Mahlangu & Makwasha, 2023). E-assessment cannot take place if the examiners and examinees do not have internet access, computing devices, or the digital skills to access and navigate e-assessment platforms. Examiners and examinees need at least a smartphone and a stable internet connection to access e-assessment platforms.

Moreover, the socio-technical theory posits that an information systems problem can be addressed by focusing on the social and technical sub-systems. This is so because the success of an information system or technical solution depends upon its social rather than technical implications (Ngqond et al., 2021). Accordingly, the theory champions that e-examination framework is composed of two modules; the technical sub-system which is composed of the authentication and continuous monitoring and social sub-system which is e-examination system enablers. The theory suggests that e-assessment frameworks should not only be at the conceptual stage or techno-centric but they should also consider the different social standing among examiners and examiners (Amigud et al., 2018*).*

Knowledge Gap

The review and analysis of the existing ICT frameworks for e-assessment are based on global best practices, the African regional context, and Tanzania situational analysis. According to the researchers, the level of adoption of e-

assessment in secondary schools globally has not taken shape as compared to higher education even though the adoption has been increasing after the COVID-19 pandemic (Margiene & Ramanauskaite, 2022; Vergonia & Mombas, 2022). In African countries, the implementation of e-assessment in secondary school is affected by limited infrastructure and inadequate access to technology. Although Tanzania has made positive steps in integrating ICT into education, a specific and concrete national-level ICT framework particularly dedicated to e-assessment has not been identified in the readily available information. Consequently, establishing a framework for the full integration of ICT in assessment in secondary schools is justified.

Methodology

The study used a qualitative approach, enabling the respondent to narrate and explain their views. The study used a descriptive research design to gain a comprehensive understanding of the phenomenon under study. Only public secondary schools with ICT were considered for the study since they could reflect the general situation of schools in Tanzania. The study was conducted in ten public secondary schools in Arusha city council in Tanzania. A total of 200 students, 20 from each school, were purposively sampled and took part in Focus Group Discussion (FGD). In contrast, 50 teachers, 5 from each school, were also sampled and interviewed. The primary data were collected from respondents using an interview as a data collection method. In contrast, secondary data was collected using documentary analysis of NECTA guidelines on the assessment procedure for secondary schools and professional levels and various frameworks for e-assessment. The primary data was analysed using thematic coding analysis. The frameworks were critically analyzed to gain more information on e-assessment and data was summarized, compared and appropriated to Tanzania context. The finding was important in establishing a framework for full integration of ICT in assessment in secondary schools. Research ethical consideration was met and upheld throughout the study; research permission was given from the authority, respondents' consent was sought, their confidentially was ensured, and they were not harmed. The findings were honest and appropriately reported.

Results and Discussions

The findings are from primary data collected from the focus group discussions, and interview while the secondary data are from documentary analysis as presented in the tables below:

Table 1: Thematic coding analysis for NECTA summative assessment in Tanzanian secondary schools

Verbatim Transcription	Themes	Codes
Our NECTA summative assessments in secondary schools are mainly manual, and ICT is minimally used; we can say the assessment is blended with some ICT. **FDG 1, FDG 3**	Nature of Assessment	NOA
Most of the activities are manually carried out in preparation for the NECTA summative assessment in secondary schools. It is more of paperwork. I wish ICT could be used in this hectic stage to reduce the workload. **I 6**	Assessment Preparations	AP
The assessment always takes a long time to be delivered from the NECTA headquarters to the students in the examination centres. This is too costly and can also compromise the security and integrity of the assessment by encouraging exam malpractices. E-delivery can address this challenge. **FDG 5, FDG 7**	Mode of Assessment Delivery	MAD
There are many students, and marking, scoring, and recording their scripts is tiresome and expensive. Imagine examiners have to travel from different regions of Tanzania to marking centres for this exercise. I wish this process could be fully computerized. It can be more effective and accurate. **I 13**	Assessment Analysis.	AA
The use of ICT has made us and our schools receive our NECTA exams very fast; immediately, the ministry releases results. We got the results from the NECTA portal. This is very nice. If all the learning processes were like this, we would enjoy it. **FDG 15**	Assessment Results Reporting	ARR
My take as a teacher, I would say that e-assessment is very effective and flexible. However, it is not currently practicable in Tanzania due to the lack of or inadequate facilitation of conditions such as ICT infrastructure, a supportive curriculum, and poor attitudes from some stakeholders. **I 28**	Barriers to E-assessment	BEA
We feel that the use of ICT in the examination will give way to the use of ICT in some stages of learning. This will make learning more flexible for most secondary school students. Therefore, barriers should be eliminated in order to use ICT in assessment fully. **FDG 19**	Merit of E-assessment	MEA

Table 1 above shows the thematic coding analysis from focus group discussions with students and teacher interviews. The results reveal that the assessment done in Tanzania secondary schools is majorly paper-based (FDG 1, FDG, 3). This is because most of the activities in stages of the assessment cycle use ICT at a minimal level (AP, I 16; MAD, FDG 5, FDG 7). However, the study established that the reporting of students' results is more computerised as compared to other assessment stages (ARR, FGD, 15). The respondents highlighted the benefits of e-assessment as being effective, flexible and more accurate than paper-based assessment (ARR, FGD, 15; MEA, FGD, 19; BEA, 28). The main factors impeding the full use of ICT in assessment were poor or lack of facilitating conditions such as ICT infrastructure, ICT integrated curriculum and stakeholder attitude (BEA, I 18). In this regard, the findings recommended that in order to have e-

assessment in secondary schools in Tanzania, the barriers should be eliminated, and e-learning should be encouraged (FDG, 19).

The findings provide significant insights into the existing assessment methods, difficulties, and prospects for ICT integration. The study indicates that NECTA summative assessments are primarily conducted manually, with limited integration of ICT, leading to a "blended" paradigm (FDG 1, FDG3). This signifies that although ICT is being implemented, its utilisation is still restricted. The findings concur with the study by Ramli et al. (2020) which noted that the use of electronic and paper-based assessment modes differs based on the stage of the assessment life cycle and the kind of assessment. The authors observed that a combination of electronic and paper-based modes is good although the electronic mode is better compared to the paper-based assessment. The combination of the two modes of assessments, paper-based and electronic, can take place in a similar stage of the assessment life cycle or in different stages.

Extensive integration could modernise the evaluation process, diminish inefficiencies, and improve overall efficacy. This concurs with Ally (2024), who reported that e-assessment is an inevitable and important part of the Tanzanian education system in the 21st century. The author observed that although e-assessment is urgently needed in schools, it is feasible for teacher education compared to secondary schools due to greater readiness in teacher training colleges. The feasibility of e-assessment is about 6.4% in secondary schools in Tanzania, specifically those that already teach computer science. Moreover, Ramli et al. (2020) observed that although examination question papers are important, their creation is very tedious, time-consuming and expensive; they are prepared with full focus, right formatting, and the right selection of questions. Consequently, the authors encourage and advocate the use of e-assessment.

Further, preparatory activities for NECTA examinations, including test scheduling and question paper management, are predominantly manual and reliant on paperwork (**I 6**). This imposes considerable burdens on educators and administrators. Therefore, incorporating ICT solutions, such as automated scheduling tools and digital logistics platforms, could optimise these operations and save time and resources.

Moreover, the delivery of assessments from NECTA headquarters to examination centres is slow, expensive, and susceptible to security threats and malpractice (FDG 5, FDG 7). Participants highlighted that digital delivery options could mitigate these problems, facilitating expedited, secure,

and economical exam distribution. Encrypted electronic delivery systems are a viable way to enhance the integrity and efficiency of the process.

The manual marking and scoring of student scripts is laborious, expensive, and susceptible to inaccuracies (**I 13)**. Hence, implementing techniques such as optical character recognition (OCR) and automated scoring systems to computerise the marking process could enhance efficiency, accuracy, and uniformity, thereby addressing a particularly time-consuming phase of assessment. Although the e-scoring is effective, the finding of Gardner et al. (2021) reported that Automated essay scoring (AES) systems can assess technical aspects of writing but struggle to evaluate the creative and higher-order dimensions of writing. Moreover, the authors noted that computerised adaptive tests (CATs) dynamically adjust test item difficulty based on examinee responses in large-scale assessment data. However, its implementation on a large scale remains challenging.

Furthermore, for assessment results reporting, ICT has previously successfully exhibited its capability in result distribution. Educational institutions can now obtain NECTA exam results nearly instantaneously via the NECTA portal, demonstrating the efficacy of information and communication technology in this evaluation phase (**FDG 15)**. Extending analogous ICT integration into the preparatory and delivery phases may produce more advantages.

Participants also acknowledged the capacity of ICT to enhance the flexibility, efficacy, and alignment of assessments with comprehensive learning processes (**FDG 19)**. By removing current obstacles, ICT might significantly improve the education system and facilitate smooth incorporation into both instruction and learning.

Despite the advantages, numerous obstacles impede the comprehensive integration of ICT in assessments (Msambwa, 2024). These factors include insufficient ICT infrastructure, a curriculum that inadequately facilitates e-assessment, and opposition from stakeholders stemming from limited awareness or negative views (**I 28)**. The findings correspond to Swai et al. (2024), who reported that although about 62% of teachers were trained in using ICT as a pedagogical, they did not use ICT in assessment, but they use it various teaching activities. Swai et al. believe that teachers did not use ICT for assessment due to inadequate equipment, lack of ICT skills, and unreliable internet and electric power issues. The authors suggested that all teachers should be trained in the use of ICT for both teaching and assessment, and the identified challenges should be addressed to enable effective integration of ICT in secondary education.

Addressing these obstacles necessitates strategic investments in infrastructure, revisions to the curriculum to correspond with digital assessment techniques, and extensive training initiatives to alter stakeholder views. The study highlights the revolutionary potential of ICT in upgrading secondary school evaluations in Tanzania. Policymakers must prioritise enhancing ICT infrastructure, revising curricula to facilitate digital assessment methods, and implementing awareness campaigns to mitigate stakeholder resistance. A phased deployment strategy, commencing with the automation of preparatory and assessment stages, may yield substantial advantages and promote wider acceptability. These initiatives will establish a safe, efficient, and adaptable assessment structure that accommodates the increasing requirements of Tanzania's education system. The Table 2 below is a summary of the findings.

Table 2: Summary of the findings from primary and secondary data on e-assessment in Tanzanian Secondary schools

	Secondary from Documentary Analysis			Primary Data from FGDs and Interview
Stages/ Cycles	**Activities**	**Model/Technology**	**Facilitating Conditions**	**Application in Tanzania**
E-Preparation	Construction of: • Test items specification table &Test items. • moderation of test items • Storage of test items	• -Test items engines with artificial intelligence technologies	• Suitable ICT infrastructure • Skills and knowledge on technology	• Test items are constructed using human item writer aided with Microsoft word. • It is pencil-paper based. No specific e-preparation model in schools More time is spent in the process and more leakage of test items. • Students & teachers are willing to shift to test item engine.
E-Delivery	-Sharing the assessment with the examinee. Communication.	• Web-based technology. • Computerized Fixed Test. • Computer Adaptive Test. • Computer-Adaptive multistage Testing	• Suitable ICT Infrastructure • Skills and Knowledge on Technology. • Institutional support. • TOE factors	• Manual delivery. • More time is spent • More assessment leakage. • No specific software to aid in delivery. • Students &Teachers are willing to shift to e-delivery model.
E-Analysis	• Marking/scoring • Recording • Interpretation /grading	• Pattern Recognition software • Computer Based Test Interpretation (CBTI)	• Suitable ICT Infrastructure • Skills and Knowledge on Technology. • Institutional support. • TOE factors	• Manual marking • Manual entry of scores in software. • Analysis is ICT assisted. • More time is spent & is prone to error. • No particular software is available • Students & teachers are willing to shift to e-analysis.
E-Reporting	• Storage • Retrieval • Transmission of feedback	• Data Based Management System (DBMS)like Oracle or MySQL	• Suitable ICT Infrastructure • Skills and Knowledge on Technology. • Institutional support. • TOE factors	• Storage is blended. • Retrieval is blended. • Transmission is blended. • Reporting is not instant. • No particular Data Based management System. • Students and teachers are willing to shift to e-reporting.

According to the findings in Table 2 above, the summative e-assessment process has four stages or cycles: e-preparation, e-delivery, e-analysis and e-reporting. The assessment is regarded as an e-assessment if all the stages and activities are computer-based. However, if the stages and activities are computer-assisted or blended with ICT, it is termed as Computer Assisted Assessment (CAA) and not an e-assessment. The literature has reviewed the various activities in every e-assessment stage, as summarised in the table. Moreover, the activities have different models or technology to support them. The findings also reveal the facilitating conditions to support the model.

Teachers and students were interviewed about how activities are performed at every assessment stage in summative assessment in Tanzania, and their views were recorded. They were also asked about the weaknesses of the models used against the e-assessment models. Further, they were asked if, indeed, an e-assessment model or technology is being employed at every stage of the assessment. Finally, the respondents were questioned on their willingness and readiness to shift to e-assessment. The findings highlight the gaps and prospects across the different stages of the assessment cycle: preparation, delivery, analysis, and reporting. During the E-Preparation phase, tasks, including the formulation of test item specifications, the moderation of test items, and their secure storage, are presently conducted manually. Test item writers depend on fundamental tools such as Microsoft Word, resulting in a procedure that is paper-based, labour-intensive, and susceptible to security vulnerabilities, including test item leaking (LaFlair et al., 2022). Technologies like artificial intelligence-driven test item engines could automate this procedure, improving efficiency and security. Nonetheless, implementing such systems necessitates appropriate ICT infrastructure and specialised expertise. Notwithstanding the constraints, educators and learners are prepared to adopt these technologies, contingent upon requisite resources and training availability.

The E-Delivery phase, which entails distributing evaluations to examinees, is predominantly manual. This conventional method is sluggish, ineffective, and vulnerable to assessment leakage owing to the absence of specialised delivery software. Adopting web-based platforms, automated fixed assessments, or computer-adaptive multistage testing may resolve these challenges. Effective execution necessitates a resilient ICT infrastructure, institutional backing, and skilled individuals. Although these technologies are not presently implemented, stakeholders

demonstrate a robust inclination to adopt e-delivery solutions for enhanced efficiency and security.

During the e-analysis phase, tasks including marking, scoring, recording, and analysing results are predominantly manual, with minimal ICT support for score entry. This manual method is laborious, susceptible to errors, and ineffective (Gardner et al., 2021). Pattern recognition software and Computer-Based Test Interpretation (CBTI) systems have the potential to automate these procedures, thereby enhancing accuracy and alleviating workload. The absence of specialised e-analysis tools hinders advancement. Educators and learners are eager to embrace innovative technology, contingent upon the availability of requisite infrastructure, training, and support.

The E-Reporting phase encompasses the storage, retrieval, and transmission of feedback, utilising a combination of manual and ICT-assisted techniques. Reporting is not immediate, and there is no specialised database management system (DBMS) to facilitate efficient storage and retrieval. Comprehensive DBMS solutions such as Oracle or MySQL can optimise this phase, facilitating adequate storage, immediate retrieval, and automatic feedback delivery. Although there is limited ICT integration at this level, both instructors and students demonstrate a willingness to shift to a completely digital reporting approach, provided that sufficient equipment and training are available (Quraishi et al., 2024).

Prevalent obstacles throughout all phases encompass deficient ICT infrastructure, constrained skills and expertise, and inadequate institutional support (Swai et al., 2024). These obstacles must be resolved to facilitate the complete incorporation of e-assessment technologies. Moreover, maintaining confidentiality and integrity during the assessment process is essential for securing stakeholder trust (Owan et al., 2023).

Although Tanzanian secondary schools predominantly depend on manual assessment processes, students and instructors are generally enthusiastic about the adoption of e-assessment technology (Ally *et al.*, 2024). The effective implementation of e-assessment necessitates investments in ICT infrastructure, training initiatives for stakeholders, and robust institutional backing. Addressing these difficulties can boost the efficiency, accuracy, and security of e-assessment, thereby revolutionising the education system in Tanzania. Based on the information gathered, as demonstrated

in Table 1, a framework for summative e-assessment in secondary schools in Tanzania is proposed in Figure 1 below:

Proposed Framework for E-assessment in Tanzanian Secondary Schools

The framework for full integration of ICT in assessment in Tanzania secondary schools considers the assessment stages, activities, suitable models, facilitating conditions and the status of Tanzania, as demonstrated below in Figure 2

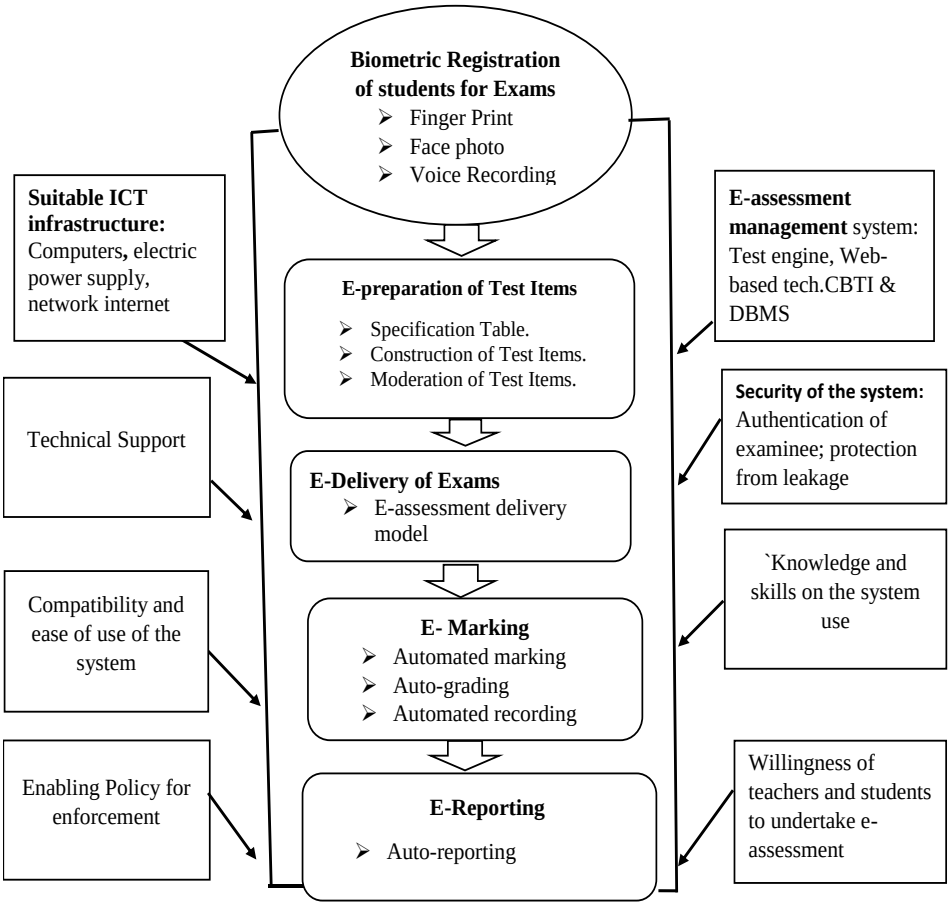

Figure 2: Framework for e-assessment in Tanzanian secondary schools

According to the framework in Figure 2, the students should be biometrically registered for exams in order to identify and authenticate them and avoid cases of impersonation. All the stages of assessment are executed or undertaken using technology or computerised until the end. The e-assessment system is also surrounded by facilitation conditions to

enable it operate. The NECTA can design the system and ensure that facilitation conditions are provided for the facilitation of the system.

Conclusion

The study has established e-assessment components and facilitating conditions, its usefulness and effectiveness in assessment and largely in the teaching and learning process. The current summative assessment in Tanzania secondary schools is generally pencil-paper based, with some computer-assisted activities. Moreover, e-assessment models are not available in schools even though teachers and students are willing and ready to shift from manual assessment to e-assessment in order to gain from its numerous benefits. The study recommends that full adoption and use of e-assessment can be enhanced by the integration of e-learning in the secondary syllabus. The government and other educational stakeholders should design policies that can provide and enforce e-assessment in secondary schools in Tanzania.

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