E-learning platforms and security mechanisms used by educational institutions in Kampala, Uganda

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Abstract: COVID-19 pandemic accelerated consumptions of e-services in the Ugandan education sector. This study aims at establishing the type of e-learning platforms adopted by educational institutions in Kampala and evaluate the appropriateness of their security mechanisms for online academic progression assessments. The researcher's adopted a mixed-method research approach for data collection and analysis. Respondents were identified using purposive stratified random sampling technique from educational institutions accredited by the Ugandan Ministry of Education and Sports to run 'open distance e-learning'. A total of 400 responded including e-learning experts, teachers and lecturers, and students. The results show that the *most popular* e-learning platforms were Zoom (87.5%) at primary, Google meet (84.1%) at secondary, WhatsApp (79.7) at secondary and Moodle (98.7%) at university. The e-learning platforms were mainly used for posting learning materials and facilitating teacher-student interactions (97.9%), but less on managing assessment for *academic progression* [universities (73.9%), secondary (50.7%) and primary (41.7%)].

Keywords: e-learning; e-assessment; COVID-19 pandemic; authentication; integrity; impersonation; Uganda.

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1   Introduction

E-learning has been defined as the use of electronic media, educational technology and information and communication technologies (ICT) in education (Contreras and Hilles, 2015; Ayoo and Lubega, 2014). E-learning includes numerous types of technology applications and processes such; as audio or video tape, radios, learner management systems (LMS), satellite TV, CD-ROM, and computer-based learning and web-based learning that help in delivering learning material (Saidu et al., 2016). E-assessment is a major activity in e-learning and has been defined as the use of technology to; digitise, make more effective, and redesign assessments and tests electronically (Redecker and Johannessen, 2013). E-assessment has several advantages over traditional assessment (paper-based) such as:

1   immediate feedback to students

2   flexibility where learners are able to learn from anywhere at any time

3   improved reliability, it is more consistent than human marking

4   improved objectivity (it does not 'know' the students)

5   greater storage efficiency – results are stored on a server compared to the physical space required for paper-based assessments (Mirembe et al., 2019).

However, e-assessment faces challenges such as; academic dishonesty, poor technical infrastructure development; commitment of students to submit assessment, difficult in scoring and correcting questions with student open response; assessing group project is a difficult job (evaluating each member and the whole group and providing feedback); some teachers are unfamiliar with technology and most of them are using e-assessment for the first time (Islam and Slack, 2015). E-learning has paved its way as a learning method into the education sector globally (Demuyakor, 2020) and with the outbreak of the COVID-19 pandemic and the lockdown that saw education institutions closed, in Uganda the Ministry of Education and Sports (MoES) together with the Uganda National Council of Higher education (UNCHE) issued a directive that all education institutions should adopt the open, distance e-learning (ODEL) to enable continuity of learning (MoES, 2001; Soni, 2020). The pandemic which started in China in 2019 later spread to the rest of the world causing a total lock down of schools affecting over 15 million learners in Uganda from pre-primary to university level thus forcing them to stay home and teachers having to teach from their homes (Demuyakor, 2020; MoES, 2001; UNESCO, 2020). This was mainly because it was difficult to observe the standard operation procedures (SOP's) such as keeping social distance as a basic guideline by the Ministry of Health together with World Health Organization (WHO, 2020) together with health officials worldwide.

The lockdown imposed by many governments implied closure of schools making e-learning the only option to support learning (MoES, 2001). Most academic heads are now promoting e-learning as a solution to this crisis (UNESCO, 2020). We observe that COVID-19 has only accelerated the uptake of e-learning as many educational institutions especially well-established universities (Tsinghua, Peking University, Harvard, MIT, Yale, Oxford, Cambridge, etc.) have over the past decade gradually been moving their academic programs online and doing away with face-to-face delivery (Bao, 2020; Filius et al., 2019).

In Uganda, the MoES together with UNCHE issued a number of guidelines promoting e-learning as a solution to the crisis and to encourage continued learning (UNESCO, 2020; MoES, 2001). Universities such as Makerere University and UTAMU adopted and utilised e-learning by following the already existing policy (the policy on ODeL). Makerere University is known to be among the first to implement e-learning using Blackboard platform but they have since shifted to Makerere University Electronic Learning Environment (MUELE) based on a Moodle platform. The university has since trained over 50 e-learning course design experts, acquired over 100 Zoom licenses to facilitate face to face interactions between lecturers and students (Mayoka and Kyeyune, 2012). Other private Universities like Clarke International University (CIU), ISBAT University, Uganda Technology and Management University (UTAMU) and Victoria University have been running blended academic programmes using MOODLE based

e-learning environment. However, according to Muyinda et al. (2010) and Mirembe et al. (2019), institutions implementing e-learning systems face a number of challenges including; unreliable internet connectivity, low bandwidth, expensive mobile data costs, inability to acquire electronic gadgets required for e-learning by both learners and teachers and lack of appropriate e-learning policies. Therefore, the MoES requires institutions to define appropriate ICT and e-learning policies to boost e-learning in the educational sector. Accordingly, MoES in Uganda has issued guidelines to enable institutions establish viable models of integrating e-learning on their programmes especially using the ODeL model and these include;

1   Education institutions are required to undertake a survey on students indicating their willingness or inability to participate in the proposed arrangements.

2   Learning institutions are expected to provide mechanisms of conduction student academic progression assessment for programmes conducted using pure e-learning systems.

3   Institutions are expected to provide detailed protocols and schemes of securing academic progression assessment to minimise cheating.

4   Avail evidence of the mechanism of access and usage of e-learning platforms by the students and staff.

5   Suggestions on how universities would address the issue of students, who are unable to acquire electronic gadgets, buy internet data and access the network (MoES, 2001).

Motivated in part by MoES guidelines and the desire to contribute to the design of robust e-learning platforms, the goal of this was to establish the type of e-learning platforms and technologies being used at various levels of education in Uganda, Kampala city in particular. It was also to assess the appropriateness of authentication and integrity approaches used in securing the academic progression examinations or assessment conducted using the learning platforms and systems. The key research questions for the study were:

1   What e-learning platforms are being used by educational institutional at various levels of education?

2   What authentication and integrity approaches are being used to secure e-learning platforms access and academic progression assessment integrity?

3   What would be the desired authentication and integrity approach to be used in e-assessment at different education levels?

4   What are the benefits and challenges of e-learning platforms?

The rest of this paper is arranged as follows; Section 2 presents the methodology, Section 3 discusses the results and analysis, and Section 4 presents the conclusion and Section 5 recommendation.

2 Methodology

The researcher's adopted a mixed methods research approach involving qualitative and quantitative methods of data collection and analysis. The respondents to the study were identified using purposive stratified random sampling technique. Respondents to the study were selected from educational institutions which were accredited by the Ugandan MoES to run 'ODEL', these included; students, teachers, lecturers and e-learning experts. The statistical sample size for respondents was determined using Cochran formula. An e-learning expert was anyone who had over ten years of designing and integrating e-learning systems in education processes and has high proficiency of using most of the common e-learning systems and platforms. The participants were selected from different education institutions from the urban centre of Kampala and surrounding areas. Respondents at primary education level were selected from (Sir Apollo Kagwa, Kabojja, Twinbrook International School, Kampala Parents and Hormisdallen Primary), Secondary education level (Uganda Martyrs Namugongo, Gayaza high school, Seeta High school and Viva College School) and University level (Makerere University, Clarke International University, Uganda Technology and Management University, Nexus International University, ISBAT University, and Nkumba University). Primary and secondary schools were selected in part due to existence of minimal e-learning infrastructures such as; internet and network facilities, well equipped computer labs and well-trained e-learning facilitators.

The primary data was collected using; expert explorative interviews, online survey questionnaires, focus group discussions, and case study analysis (observation). The literature review was conducted using the 5C framework (cite, compare, contrast, critique and connect). A total of 450 respondents were targeted including; e-learning experts (10), teachers and lecturers (60), and students (380). A total of 400 respondents; eight were experts, 347 students (48 primary, 69 secondary and 230 university), 30 lecturers and 15 teachers (both primary and secondary schools). A total of 15 institutions were sampled (six universities, four secondary schools and five primary schools). Majority of student respondents had used a computer at least for one year and completed at least five online classes. Implying their opinions could be relied on to make sound deductions about the state of e-learning usage in their institutions.

Data collection was done in two phases; the first set of data was collected for a period of three months (March, April and May 2020) and the second set of data was collected January-March 2021. Key informant interviews with experts and teachers were conducted using; physical meetings, Zoom, WhatsApp and Skype. Observation and case analysis were applied where two cases were observed. Additionally, to ground this work the researchers also conducted the secondary data analysis using systematic literature review approach where a number of articles between years 2015–2020 were reviewed on topics; e-learning, e-learning platforms, e-assessment, authentication and integrity in e-learning systems including; 30 conference papers, 60 peer reviewed journal articles.

2.1 Study results and findings

A total of 400 responded to the study of whom (243)60.5% were male and (157)39.5% were female.

Table 1   Summarises the gender demographics of respondents

Category	Gender		
	Male	*Female*	*Actual respondents*
Experts	6	2	8
Students	210	137	347
Teachers	7	8	15
Lecturers	20	10	30
Total	*243*	*157*	*400*

It was noted that in every category of respondents the female were fewer than male.

A total of 15 education institutions were considered for this study, five primary schools; four secondary schools and six universities. It was important to categorise the respondent's level of participation in order to draw a good conclusion on the representation of data for the study. At least (48)13.8% respondents were from primary, (69) 19.9% at secondary and (230)66.2% from the university.

Table 2   Level of participation per school/university

Schools	No. schools/university	No. of respondents	Percentage (%)
Primary	5	48	13.8
Secondary	4	69	19.9
University	6	230	66.2
Total	*15*	*347*	*100*

It was noted that majority of the respondents in this study were students at university level an indication that they are more enthusiastic about technology and e-learning usage which is a *key segment for furthering or enhancing e-learning platforms usage in Uganda*.

3   Years of experience with computer usage

In terms of respondents' years of experience with computer usage, a big number 35/48 at primary had experience of less than one year (< 1 yr), at secondary 44/78 had experience of 1–3 years followed by 24/68 who had experience of less than 1 year (< 1 yr), at university level majority had experience of 1–3 years while a few 50/230 had experience of 4–9 years.

It was noted from the study as represented in Table 3 that a big number (170/230) of respondents at university level had experience of 1–3 years which was a good indication that they could easily use e-learning platforms. The respondent's demographics imply their opinions can be relied on to make sound conclusion on the research questions.

Table 3 Years of experience with computer usage

Education level		Years of experience	Usage by level of education
Primary	a	< 1 yr	35
	b	1–3 yrs	13
	c	4–9 yrs	0
	d	More than ten yrs	0
Secondary	a	< 1 yr	24
	b	1–3 yrs	44
	c	4–9 yrs	1
	d	More than ten yrs	0
University	a	< 1 yr	10
	b	1–3 yrs	170
	c	4–9 yrs	50
	d	More than ten yrs	0

3.1 E-learning platform categories

E-learning platforms were categorised into synchronous and asynchronous as indicated in Table 4.

Table 4 E-learning platform categories

E-learning platforms	Level of education	Technology
Asynchronous	Primary	E-mails
		WhatsApp
	Secondary	Moodle
		Websites
		E-mail
	University	Moodle
		E-mails
		WhatsApp
Synchronous	Primary	Zoom
		Google meet
	Secondary	Zoom
		Google meet
		Big blue button
		WhatsApp
	University	Zoom
		Video conferencing
		Skype
		Google classes

3.1.1 *E-learning platforms currently used*

This research sought to find out the type of e-learning platforms currently being used at different education levels and results indicated that; at *primary level* majority used Synchronous e-learning platforms Zoom (87.5%); Google meet (35%) and big blue button (26%). At secondary level, majority are using Google meet (84.1%); followed by Zoom (81.2%); and the least used at secondary of the asynchronous platforms was Moodle (15.9%); e-mails (42.0%). Results also revealed that at university level, majority (98.6%) of respondents used Asynchronous e-learning platforms built on Moodle framework, e.g., Makerere University used MUELE (Makerere University e-learning) while Nkumba University used NUELE (Nkumba University e-learning). Survey results indicate that Zoom was the commonly used at all educational levels 87.5% at primary, 86.1% at university and 81.2% at secondary as shown in Figure 1.

Figure 1   E-learning platforms used by educational institutions at different levels of education (see online version for colours)
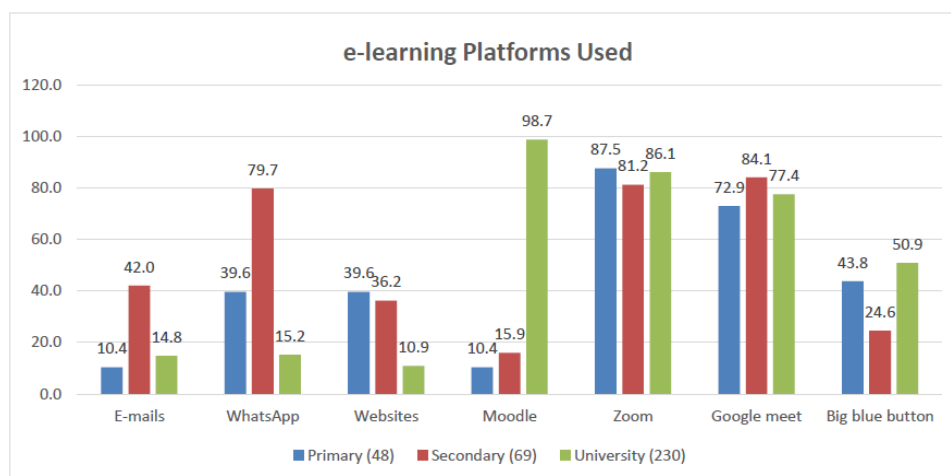
From the focus group discussions and key informant interviews with teachers and lecturers it was revealed that synchronous e-learning platforms with visual technologies such as Zoom (87.5%), Google meet (84.1%), WhatsApp (79.7%) were mostly preferred because; they provide real-time interaction, enable collaborative and interactive learning and ability to mimic experience of in person classroom environment. Synchronous e-learning platforms increased the ability to monitor and control learners during learning sessions especially learners at Primary level who learn better through playing, singing. This information correlates well with the information from experts that revealed that majority (75%) of learners at Primary learn better through interactive programs that give chance to ask questions and receive instant responses from teachers and visual learning aids. Further still, synchronous platforms offer learners increased ability to ask questions, gives teachers and lecturers ability to monitor the learner's participation in e-learning activities.

     One expert from Makerere University noted that:

> "Learners at lower levels such as at primary level, learn best through visualising, singing, playing, reciting and demonstrating what they are being taught".

As told by one of the learners during the focus group discussion

> "My father said we shall not go back to school because there is Corona Virus, and I see my teacher on Zoom camera from my mother's phone".

It was noted that all universities were using Moodle based platforms because it was open source, cheap to acquire and there was in country technical expertise to install and support the system. Companies like Eight Tech Consults and 77 consulting are some of the e-learning experts in the area.

From the focus group discussion with lecturers, it was revealed that majority of students at university level prefer self-paced learning (asynchronous) especially the working class since they have the freedom to learn anytime, anywhere; and also, are free to download learning materials and assignments, attempt them and submit to the message board. As noted by one expert in an interview:

> "Some of the learners at University level are self-driven and have the ability to learn anywhere, anytime and have the capacity to download learning content easily".

3.2 Benefits and challenges of e-learning platforms

As noted by teachers and lecturers at different education levels (primary, secondary and university) in the key informant interviews and focus group discussions held, it was noted in the results that e-learning platforms (asynchronous and synchronous) were used for posting learning materials; facilitating teacher-student interaction; coursework delivery via the institutional websites, e-mails and message boards. Also, students are given chance to complete the course at their own pace. One senior lecturer at Makerere University from the institute of open distance and e-learning said;

> "Learners at University level are self-driven and have the ability to schedule their learning time (learn from anywhere, anytime), also learners who are working are given chance to work as they study".

Majority 6/8 (75%) experts indicated that synchronous e-learning platforms are free and are mostly preferred due to their convenience and interactive nature(real-time) which is a critical requirement in formative years of education that rely on visual learning. The opinions of majority of teachers engaged in the focus group discussions confirmed that; scheduled exams are more like traditional exams which are scheduled to be completed at a specific time and date which hence forth encourages learners not to miss any of the assignments since there will be no chance of another exam.

It was interesting to note that learner's ability to freely interact with fellow learners is increased through discussion forums and chats. However, it should also be noted that; e-learning platforms currently used (asynchronous and synchronous) can freely be downloaded onto any electronic gadget (mobile phones, laptops, desktops); are reliable as long as one has internet connection (data bundles) and besides they are easy to use by following simple instructions.

In terms of Authentication to access e-learning platforms and authentication required to access academic progression assessment, it was noted by one expert from Nkumba University that;

> "The auto generated passwords are shareable and too easy to guess at (123) thus learners are tempted to share with unauthorized learners which makes them susceptible to cheating and impersonation if used for e-assessment".

However, it was also noted that interactive meetings such as Zoom are expensive in terms of data bundle costs with approximately 540 MB to 1.62 GB per hour (approximately five thousand Ugandan shillings 5,000/=) for a 1:1 Zoom meeting and 2.4 GB per hour for group meetings Zoom's data consumption depends on factors such as; the quality of your stream, how many people are on call and also whether the user is using any collaborative features such as video (screen sharing) (Abbott, 2020 as cited in Budiman, 2020).

3.2.1   *Purpose of e-learning platforms*

Results presented in Figure 2 indicate that 97.9% of respondents at *primary* used e-learning platforms for facilitating teacher-student interactions; followed by 87.0% used for posting learning material at university level; managing assessment (73.9%) among other purposes. It was also revealed by learners at university level that; they used e-learning platforms for other purposes such as; group discussions, assignments submissions and getting updates of school activities.

Figure 2   Purpose of e-learning platforms by students, teachers and lecturers (see online version for colours)
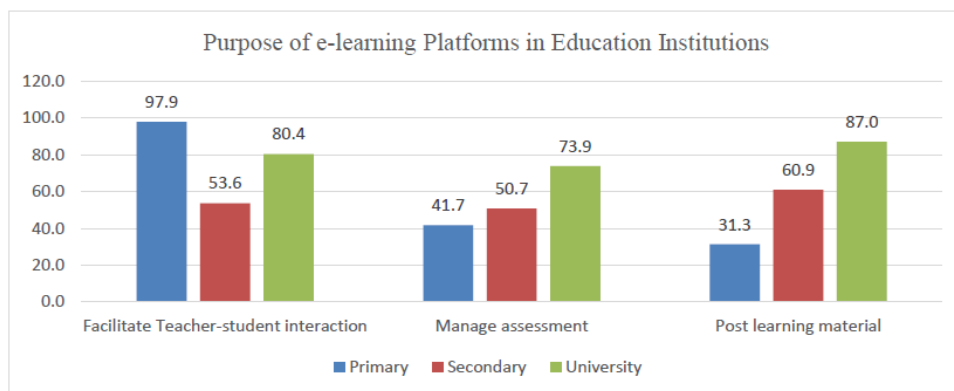
From the study results in Figure 2, at primary level, e-learning platforms were majorly used for facilitating teacher-student interaction (97.9%) taking advantage of platforms with video conferencing features. Considering asynchronous e-learning platforms, they were majorly used at university for posting learning materials (87.0%) which would later alone be downloaded by learners. It was also noted that learners who studied as they work; and those that could not make it for the scheduled classes benefited more from the uploaded learning materials on the e-learning platforms.

3.3 E-learning platform authentication access control

In terms of e-learning platform access control, all the 15/15 education institutions confirmed to use username and password, while only (2/15) indicated to use biometrics (face recognition, finger print) for e-learning system access control. Table 5 summaries the findings

Table 5 Authentication and integrity approaches used to access e-learning platforms

Education level	Authentication	Usage
Primary	Passwords	95%
	Biometrics	None
Secondary	Passwords	92%
	Biometrics	None
University	Passwords	90%
	Biometrics (face recognition, fingerprint)	16.6%

Based on the results from Table 5, over 90% respondents agree that passwords are the commonly used authentication approach while accessing e-learning platforms. This has been attributed to its simplicity and ease of use thus not requiring further configuration. Further studies according to reviewed literature confirm that biometrics such as; face recognition have not been commonly utilised because it is considered expensive and requires sophisticated software. Further still, studies indicate that although passwords are commonly used, they cannot be relied upon to curb down academic dishonest such as cheating, impersonation and plagiarism (Okada et al., 2019).Therefore, it is important to integrate *biometrics such as face recognition control with password authentication* as a way of strengthening access to e-learning platforms and monitoring access to academic progression.

It is also important to note that continuous verification of learners that wish to undertake any form of computer-based examination (tracing academic progress assessment) should be monitored through confirmation of a learner's presence throughout the examination.

3.4 Proposed authentication approaches for different education levels

Authentication approaches define the requirement for verification of a user to ensure he/she is who they claim to be. Authentication has been categorised depending on the security it provides to the user (1FA – one factor authentication, 2FA – two factor authentication and 3FA – three factor authentication). An authentication based on knowledge is the most widely used method for user identity verification and is either based on password or challenge/response system. Other authentication approaches such as biometrics (finger print, face recognition) provide better security and should therefore be integrated with passwords to strengthen authentication in e-learning platforms at different education levels as shown in Table 6.

Students' intentions to cheat during online assessments have been seen to have a big influence on the choice of authentication to use at each education level. Therefore, a one factor (IFA) such as simple passwords was said to be appropriate at primary level since they are easy to remember and learners at this level do not have intentions to cheat unless

they have been assisted to, moreover use of biometrics such as face recognition at this level was found to be convenient and fast and learners can easily be identified by their unique features.

Table 6   Proposed Authentication approaches for different education levels

Level of education	E-learning technology/platform	Authentication	Description
Primary	Synchronous	1FA (one factor authentication such as simple passwords) biometrics	Use obvious, guessable, simple passwords (123, student's name) and biometrics (face recognition) whose features cannot be exchanged and can easily be captured.
Secondary	Asynchronous and synchronous	• Strong passwords (alpha-numerical) • One time passwords (OTP) • (2FA) two factor authentication password+ code sent on text message on users' phone/e-mail.	Enhanced security reduces fraud rate and adds a layer of security (alpha-numerical + graphical password). This is required at this level because; increase in education level increases the urge to cheat exams.
University	Asynchronous and synchronous Moodle	(3FA) three factor authentication multifactor authentication (something you know-password, something you have-token/card, something you are-finger print/face recognition).	Strong affirmation-make layered hindrance for unauthorised people to get into the system. In case one layer is broken (for example Password) the attacker has more layers before getting into the system (Finger print or card) to bypass 'as you go higher the incentive to cheat goes up thus stronger security is required'

For learners at secondary and university level, they are more enthusiastic on technology advancement and usage and are likely to identify loopholes in authentication approaches (such as alpha-numerical Passwords). It is therefore fair to conclude that *the higher the level of education the stronger the security* required. For this case, a (2FA) two factor authentication and (3FA) Three Factor Authentication-Multifactor should be considered to strengthen authentication thus making it difficult for unauthorised individuals to access the system.

In an interview with lecturers, it was revealed that ~70% of the learners would be willing to cheat exams if they get a chance, this was attributed to learners' wish for better grades without putting in effort to read hard. This information correlates well with information from literature (Adetoba et al., 2017) assert that 73.6% of learners think cheating in an online environment is easier than in traditional classroom setting. The higher the level of education the more the intentions to cheat therefore it is correct to say that stronger security is required in e-learning environment that involves a 2FA two factor authentication (alpha-numerical + graphical passwords). However, passwords if used alone are vulnerable to attacks, can be easily broken and are also prone to hacking

(Gathuri and Kamundi, 2014; Vaithyasubramanian et al., 2015). However, due to the role played by passwords, there is need to enhance security through multiple layers of authentication (3FA – three factor authentication).

3.5 Willingness to take online assessment

This study further sought to find out learners' willingness to take online assessment having noted that e-learning platforms were used for teaching and learning. Results revealed that majority 190/230 (82.6%) respondents at university level were willing to take online examinations at a high level and at primary level with low willingness (72.9%) as illustrated in Figure 3.

Figure 3 Level of willingness to take online assessment (see online version for colours)
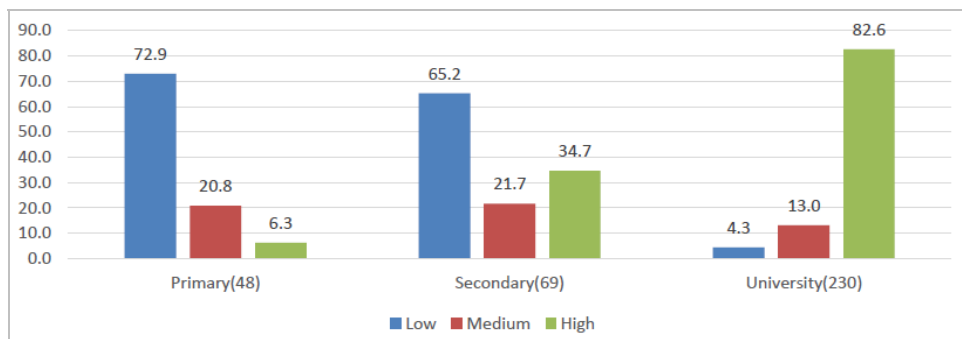
Interesting to note from this was that some learners at primary and secondary level lacked confidence in computer skills and partly why they were not willing to take online assessments. Whereas at university level, the willingness to take online assessment was high (82.6%), this was attributed to student exposure to electronics; advanced knowledge in technology; and ability to use electronic gadgets for other e-services. The high-level knowledge of university students has increased their ability to cheat taking advantage of gaps existing in the systems at hand. From the key informant interviews held with one expert from Makerere University, it was noted that: 'As you go higher the incentive to cheat goes up'. The results from key informant interviews with experts further revealed that, the desire to commit academic dishonest increases from lower education levels (primary) to higher education (university) as student cognitive ability increases and stakes of academic progression increases. Furthermore, simpler access controls like biometrics are ideal for lower educational level while complex access control mechanism such as Multifactor schemes are ideal for advanced education levels. A programmatic authentication scheme for academic progression assessment therefore, MUST provide biometric features in the schemes to minimise student impersonation which can compromise the integrity of the assessment.

Therefore, at policy level the MoES should consider introducing computer studies at early stages of learning say primary level to enable learners familiarise with computer usage and further be educated on the need for academic honest (online or offline).

4   Recommendations

Therefore, from this study the following should be done:

1   Education institutions using e-learning platforms should consider having policies and frameworks suitable for the different education levels to be integrated in learning and assessment.

2   Inclusion of biometrics and consideration of at least a two layered authentication approach to enhance security.

3   Authentication and integrity should be strengthened to suit the education level into; (*1FA*) one factor authentication to be used at primary education and a combination of authentication approached into; (*2FA*) two factor authentication (alpha-numerical + graphical passwords) and (*3FA*) three factor authentication (multifactor authentication) a combination of what you have (USB, dongle)+ what you are (biometrics like face recognition/finger print) + what you remember (passwords) + what you do(quasi-biometrics such as typing style on a keyboard) to be used by higher education levels for stronger authentication.

4   Government of Uganda and educational institutions should advocate for embedding cyber security in the curriculum at early stages of learning so that learners are taught the need for information security at their early stages of learning. Also, more sensitisation programs should be enacted such as e-learning policies and laws to guide e-learning users.

5   Adoption and collaboration with companies which provide critical e-learning infrastructure such Amazon and Digital Ocean should be encouraged and other service providers such as Roke Telecom, Airtel Uganda, and MTN should pattern with the government to provide subsidised, hosting, internet and bandwidth rates to enable quick access to e-learning platforms and technologies. This way a big number of learners, teachers and lecturers will be catered for.

6   Consideration of blended learning technology especially for the practical oriented courses such as Health, Agriculture and Engineering courses. A combination of self-paced learning and online interaction will serve a great purpose.

Our future work will consider designing a multifactor authentication model to monitor learners' step by step as they undertake online assessment.

5   Conclusions

E-learning platforms and technologies that facilitate virtual learning, video conferencing are rapidly increasing day by day and especially to handle the crisis that was caused by COVID-19 in the academic institutions. Learners are finding it more interesting and fun to interact with their teachers and lecturers online, the ability to do self-study has enabled learners to be more innovation and a better way to acquire additional knowledge world over. It has been revealed by this study that several e-learning platforms and technologies (e-mails, websites, WhatsApp, Zoom, Google meet, Google classroom, Moodle and Blackboard) have enhanced learning and assessment at various education levels. This

study further revealed that participating education institutions did not have authentication control policies and frameworks in place for the different education levels (primary, secondary and university) and besides it was revealed by the study that there is no uniformity on the e-learning platforms used. Moreover, the e-learning platforms were mainly used for learning, downloading notes, assignments, chats, discussions and90very few were using them for assessment purposes. This was attributed to lack of enough technology to monitor learners as they undertake the examinations/assessments moreover education Institutions needed to proof their ability to monitor learners as they undertake the examination. The condition to use security techniques such as biometrics (face recognition) while examining students was set by the Ugandan MoES together with the UNCHE (2020) during lockdown as a secure way of ensuring that learners examined are monitored by their biometric features from the beginning to the end.

The results show that the *most popular* e-learning platforms were; Zoom (87.5%) at Primary; Google meet (84.1%) at Secondary; WhatsApp (79.7) at Secondary and MOODLE (98.7%) at university. The e-learning platforms were mainly used for posting learning materials and facilitating teacher-student interactions (97.9%), but less on managing assessment for *academic progression* [universities (73.9%), secondary (50.7%) and primary (41.7%)]. In terms of platform access control, all institutions sampled (15) were using token (username and password) implemented on the principle of role-based accesses control and the least used was biometrics.

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