International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2018, Vol. 14, Issue 3, pp. 50-71

Exploring assistive technology tools and e-learning user interface in Tanzania's vocational education institutions

Dalton Kisanga, Deusdedith Wambura and Finian Mwalongo
Dar es Salaam Institute of Technology, Tanzania

ABSTRACT

Students with hearing impairment (HI) face challenges in learning including accessing educational information electronically. This study sought to assess assistive technology tools and existing e-learning user interface for students with HI in Vocational Education and Training Authority (VETA) institutions in Tanzania. The study is guided by three objectives: First, it assesses the current e-learning user interface for students with HI. Second, it identifies hearing impairment assistive tools used and finally it suggests suitable measures for addressing the situation.

The study involved 89 participants obtained using purposive sampling and simple random sampling. Data were collected using questionnaires and semi-structured interviews. The qualitative data were then subjected to thematic analysis.

Findings revealed challenges associated with poor communication with others, poverty from parents/guardian, unfavourable physical environment and shortage of hearing aids tools and special needs teachers. Similarly, findings from different usability factors such as effectiveness, easiness of use, and accessibility showed that the participants were not completely satisfied with the current e-learning user interface system and assistive technology tools. Therefore, the study recommends the development of a better e-learning user interface with integrated assistive technology for students with HI to enhance their participations in learning.

Keywords*: e-learning; students with hearing impairment*

INTRODUCTION

Hearing impairment is the most prevalent sensory disability in the globe and a condition of growing concern (WHO 2012; Thorne, et al 2016; Mulwafu, Kuper & Ensink 2016). Estimates released by the World Health Organization (WHO) in 2012 shows that there are 360 million people with hearing loss, about 5.3 percent of the world's population (WHO 2012). Recently, WHO released new estimates that there are 466 million people with hearing loss, about 29.4 percent higher than the 2012 estimates (WHO 2018) and the prevalence of hearing loss is higher in South Asia, Asia Pacific and sub-Saharan Africa (WHO 2012; Thorne, et al 2016; Ramma & Sebothoma 2016; Mulwafu, Kuper & Ensink 2016). In fact, the number of people affected by hearing impairment continues to rise due to ageing and the growing noise pollution in our environment (Ramma & Sebothoma 2016; Guthrie et al 2018). WHO (2018) estimates the number to rise over 900 million people by 2050.

In Tanzania, people with disabilities constitute 6.01 percent of the general population as the 2012 Population and Housing Census indicates (URT, 2014). The data collected during the 2012 census indicate that there are 2,641,802 people with various forms of disability (URT, 2014). This number constituted six percent of the total population enumerated in this census of which, 2,567,088 were from Tanzania Mainland and 74,714 from Tanzania Islands (also known as the Zanzibar archipelago). The number of people with hearing impairment according to the 2012

census is 410,182 (URT, 2014). This number constituted 0.96 percent of the total population of which 328,174 were from Tanzania Mainland and 82,008 from Zanzibar (URT, 2014).

In an evolving society based increasingly on receiving information through informational and communication technologies, e-learning environment for people with disabilities need integration in their formal and alternative education. The rapid development in ICT has enabled students with special education needs to overcome their learning barriers (Jain, Rao, & Basal, 2014). Literature has consistently shown that educational technology has the potential to support the inclusion of special education needs in classrooms (Wejdan & Kalpdrum, 2016; Jain, Rao & Basal, 2014; Catalano, 2014). When pursuing this subject, a diverse range of special needs students' issues, both technical and nontechnical need to be considered. Some studies, for example, Almond *et al.* (2010) and Buzzi, Buzzi and Leporini (2009) show that most of the technical issues with e-learning systems reported by the students with special education needs are paid little attention. Accordingly, educational institutions invest large amounts of time and resources in ICT, aimed at enhancing the educational effectiveness of the learning environment (Decman 2015).

However, many initiatives are in place to support the right to education of people with disabilities, to raise awareness and to encourage the dissemination of good practice (UNESCO, 2015). Tanzania has several laws, policies and documents pertaining to people with special needs. These are highlighted in the Education for all (EFA) report (URT 2015), Universal Primary Education in Tanzania (UPE), The Tanzania Development Vision 2025 (URT 1998), Primary Education Development Program (URT 2012), and Tanzania Persons with Disability Act of 2010.

The right to education is a fundamental human right that needs protection for everybody to enjoy like any other human right (UNESCO, 2009). To build and develop the country and welfare of the people, education remains fundamental important and high priority area in Tanzania (URT 1995; URT 1998; Okkolin, 2013). Before the coming of special schools in Tanzania, learners with disabilities were totally "isolated physically, socially and academically" from others (Tungaraza, 2012, p. 17). Today, learners with disabilities have opportunities to access education and attend inclusive primary schools in the country alongside leaners without disabilities, which is in line with the Universal Design for Learning (UDL) that focuses on design of instruction/course that meets diverse needs of learners (Brokop, 2008) regardless of their disabilities.

Tanzania is one of the countries that endorsed the Salamanca statement in 1994 that foster the right to education for children with disabilities in inclusive settings (TFDPO, 2010). As a result, Education for All (EFA), which is aimed at providing quality education for all learners, led to the introduction of inclusive education in Tanzania (Tungaraza 2012) which in turn, resulted in the inclusion of learners with hearing impairment in ordinary primary schools, secondary schools, and vocational education institutions (Hakielimu, 2008; Tungaraza, 2012).

In Tanzania, vocational education institutions are co-ordinated and regulated by Vocational Education and Training Authority (VETA). VETA is an autonomous government agency responsible for co-ordinating, regulating, financing, providing and promoting vocational education and training. VETA provides education and training opportunities to trainees upon their completion of primary and secondary education (VETA, 2010). Learners get training to take up careers as skilled workers, for industrial and self-employment. VETA owns 22 vocational training centres and co-ordinates 889 other centres, owned by non-governmental organisations, governmental agencies and individuals, throughout the country (VETA, 2010). VETA (2010) reports that 15 of the 22 VETA centres and 190 non-VETA centres conduct computer courses. These courses range from basic e-learning literacy to technical maintenance, support and network administration (VETA, 2010). VETA conducts training for all trainees regardless of their disabilities.

The learning process involved by students with hearing impairment is not different from other trainees in vocational education institutions. However, these students face a number of barriers that other students do not. UNESCO (2013) reports that people with disabilities face a wide range of challenges, including access to information, education and a lack of job opportunities.

STATEMENT OF THE PROBLEM

E-learning presents great opportunities for students with disabilities and in particular those with hearing impairment when suitable education methods and appropriate technology are available (UNESCO, 2012). Generally, e-learning improves access to quality educational resources by providing improved informational content and learning approaches such as critical thinking and problem solving (Olson, 2011).

In Tanzania, students with disability face with problems such as insufficient learning and teaching resources, shortage of special education need teachers, unfavourable physical environments, poor co-operation among teachers themselves, and between teachers and parents (Hakielimu 2008; Kiomoka, 2014; Kisanga 2017). Consequently, very few students with hearing impairment reportedly excel from secondary education to higher education (Migeha, 2014; Kisanga 2017). This suggests that there is low percentage of students with hearing impairment who reach higher education levels. The implication is that VETA could become an alternative option for these students to acquire numerous professional skills and live independent life when the learning and teaching environment improve in terms of the effective application of assistive technology. However, the e-learning user interface available constitutes another challenge for students with hearing impairment as they have limited assistive technology tools such as amplification device, telecommunication device, captioning and speech to text as well as sign language to text translator (Jain, Rao, & Basal, 2014).

Different scholars and studies have investigated the role of e-learning user interface in education systems, particularly students with disabilities (Brokop, 2008; Hashim, Tasir, & Mohamad 2013; Jain, Rao, & Bansal, 2014; Wejdan & Kalpodrum, 2016). However, most of these studies originate from other parts of the world, with different operational environments from those obtaining in Tanzania. As such, there is limited specific knowledge pertaining to Tanzania and particularly for students with HI in VETA institutions. This study, therefore, seeks to fill this knowledge gap by exploring e-learning user interface and assistive tools used in Tanzania's vocational education institutions if they meet needs of students with hearing impairment.
To achieve its objective, the study was guided by the following research questions:

a. What challenges do students with hearing impairment face during the learning process?
b. What challenges of the existing e-learning user interface do students with hearing impairment at VETA institutions face?
c. What type of hearing impairments assistive tools do students with hearing impairment in Tanzania use?
d. What are the suitable measures/strategies with which to overcome these challenges?

METHODOLOGY

The study involved three vocational education institutions (reference removed for anonymity), which were purposively selected because they have students with hearing impairment and, thus, had relevant data required by the authors. Data were collected from students with and without hearing impairment, heads of institutions (principals) and teachers who were also purposively selected.

The study used purposive sampling to select all the students with hearing impairment because they were the key respondents of the research. Similarly, purposive sampling helped to select academic principals of the three institutions based on the assumption that they have relevant key information due to their strategic management positions. Furthermore, purposive sampling helped to select teachers teaching students with hearing impairment.

Simple random sampling, on the other hand, was deployed to select students without hearing impairment. For the purpose of the study, authors were interested with 50 students without hearing impairment who were classmates of students with hearing impairment. Using Cohen, *et al.,* (2011, p. 147) sample size statistical table with sampling error of 5% and confidence level of 95%, the sample size for the population of 50 was 44. These students were assigned a consecutive number from 1 to 50 and a simple random number generator (www.randomizer.org) was used to choose 44 students. However, only 30 students turned up. Simple random sampling technique was used to have unbiased representativeness of the population.

Therefore, 45 students with hearing impairment, 30 students without hearing impairments, 3 principals and 11 teachers were involved in the study, hence 89 participants (Table 1).

Table 1. *Population vs. number of participants involved in the study*

S/N	Name of Institution	Actual No. of Teachers	No. of Teachers Participated in the Study	Actual No. of students	No. of Students Participated in the Study	Actual No. of Students with HI	No. of Students with HI Participated in the Study
1	Inst. 1	19	3	252	14	8	8
2	Inst. 2	194	6	1318	33	21	21
3	Inst. 3	16	5	220	28	16	16
Total		229	14	1790	75	45	45

The research personnel comprised of two senior and one junior staff from Dar es Salaam Institute of Technology. Data were collected using face-to-face semi-structured interviews supported by closed-ended questionnaires. Questionnaire were administered in the classroom (during free time) for about 10 minutes to complete whereas interviews were conducted in staffroom and lasted for about 25 minutes.

All ethical issues such as informed consent, anonymity and confidentiality were observed throughout data collection (DPA, 1998; BERA, 2011). Participants were also informed about the right to withdraw from the study during any stage of data collection process as their participation was on voluntary basis. In addition, a research permit was obtained from the Centre Management of VETA Dar es Salaam. Anonymity of research sites and participants were guaranteed by disassociating names during data collection, analysis and interpretation processes.

FINDINGS

Demographic information of respondents

This study had 89 respondents comprising three (3.4 %) principals, 45 (50.5 %) students with hearing impairment, 30 (33.7%) students without hearing impairment and 11 (12.4%) teachers. Table 2 presents the demographic characteristics of the respondents:

Table 2: *Demographic characteristics of respondents*

Participant	Male	Female	Total
Students with Hearing Impairment	35	10	45
Students without Hearing Impairment	20	10	30
Teachers	6	5	11
Principal	2	1	3
Total	63	26	89

Generally, information from Table 2 shows that the majority of the respondents in this study were students with hearing impairment who were the key participants of the study.

Further analysis of data collected in terms of gender shows that out of the 89 respondents involved in the study, only 26 (29%) were females with 63 (71%) being males. In other words, the study was overwhelmingly dominated by male respondents primarily because the number of males at vocational education institutions is far higher than that of female due to the nature of vocational study, duties and responsibilities that are largely perceived to be male dominated in the largely patriarchy-dominated Tanzania society.

Challenges students with hearing impairment face

The first research question sought to explore the challenges students with hearing impairment face during the learning process. All the 89 participants responded to and identified the following factors as presented in Table 3 (below): 27 (30%) indicated poor communication with others, 11 (13%) cited shortage of special needs teachers, 13(14%) shortage of hearing aids tools, 18 (15%) unfavourable physical environment and 20 (22%) indicated poverty among their parents/guardians.

Table 3*: The Challenges Students with Hearing Impairment Face*

Challenges	Frequency	Percent
Poor communication with Others	27	30%
Shortage of special needs teachers	11	13%
Shortage of hearing aids tools	13	14%
Unfavourable physical environment	18	20%
Poverty from parents/guardian	20	22%
Total	**89**	**100%**

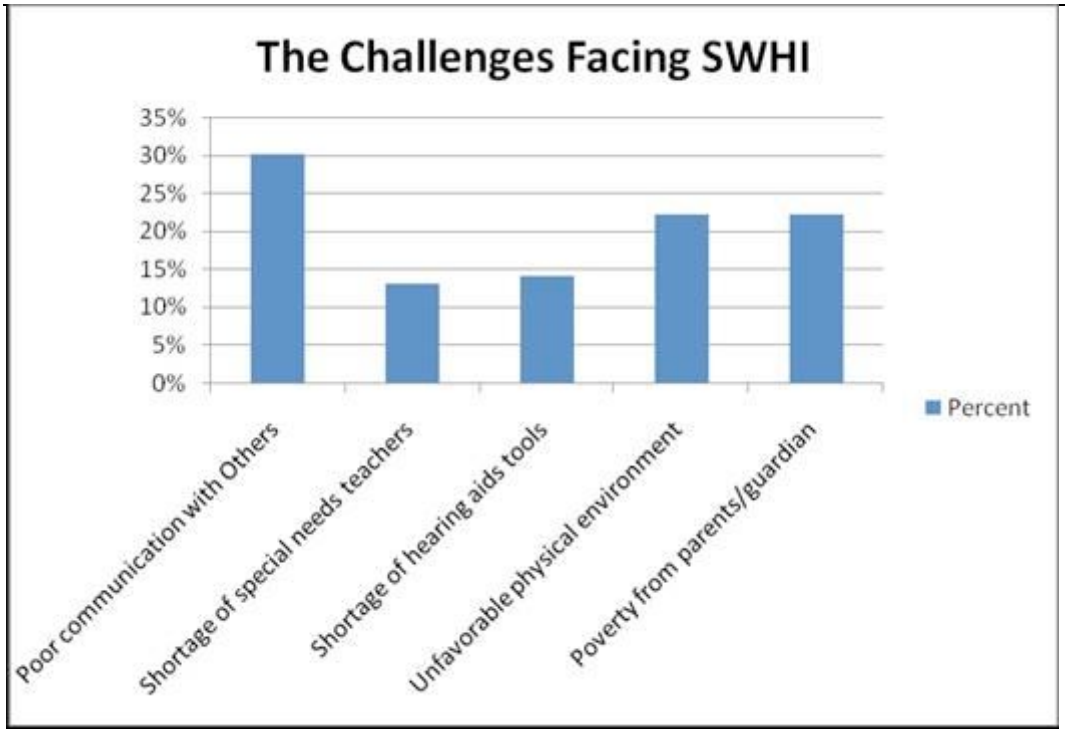

***Figure 1**: Challenges faced by students with Hearing Impairment*

Figure 1 shows that challenges associated with *poor communication with others* were highly cited than other factors. Data showed that 27 (30%) participants cited this problem. *Poverty among the parents/guardians* was the second largest cited challenge with 20 (22%) participants citing it followed by *unfavourable physical environment,* which was cited by 18 (20%) of the participants. Challenges related to the shortage of hearing aids and shortage of special needs teachers were cited respectively by 13 (14%) and 11 (13%) of the participants. Findings related to poverty suggest that, the majority of the students with disabilities including those with hearing impairment come from families with low economic status. In this regard, their hearing loss could have resulted from lack of timely medication during the onset of hearing problems.

Assessing the existing e-learning user interface for students with HI

Currently, the three institutions involved in the study are using V-SOMO (see http://www.veta.go.tz/index.php/en/newsbyID?new=134) to facilitate learning. V-SOMO (Figure 2) is a mobile learning application aimed at supporting learning vocational technical skills all over the country. Users are required to download the app using a play store available in their smartphones. The V-SOMO app offers 40% theory learning and 60% of a face-to-face practical learning offered at any nearby VETA institution in the country.

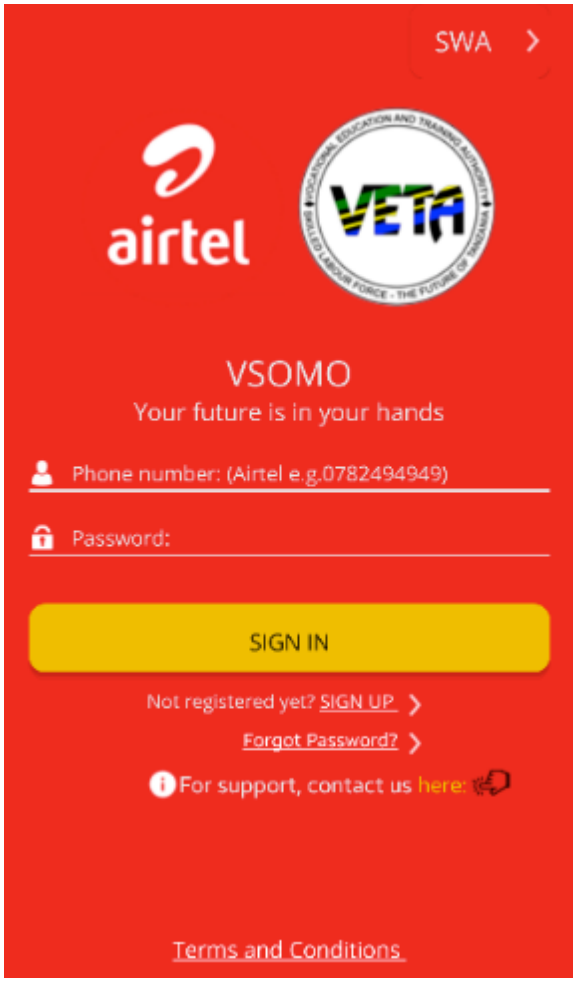

Figure 2: *A V-SOMO mobile app*

Thus, the second research question sought to assess the existing e-learning user interface for students with hearing impairment in VETA institutions in terms of the system access to information, ability to read Webpages in user interface and accessibility of the system itself. In particular, the study aimed to answer the research question: "What challenges of the existing e-learning user interfaces do students with hearing impairment face?"

Questionnaires were distributed to all the 75 students with and without hearing impairment. Participants were then requested to express their degree of agreement with each question on a five-point scale consisting of the following responses: *Strongly Agree (SA), Agree (A), Neither Agree nor Disagree, Disagree (D)* and *Strongly Disagree (SD)* [Table 4].

Table 4: *Students' responses about user interface usability*

UI Usability	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Total
Q1	15	26	3	20	11	75
Q2	20	27	3	20	5	75
Q3	15	24	3	20	13	75
Q4	7	26	2	29	11	75
Q5	13	17	6	28	11	75
Q6	27	25	3	10	10	75
Q7	24	39	3	4	5	75

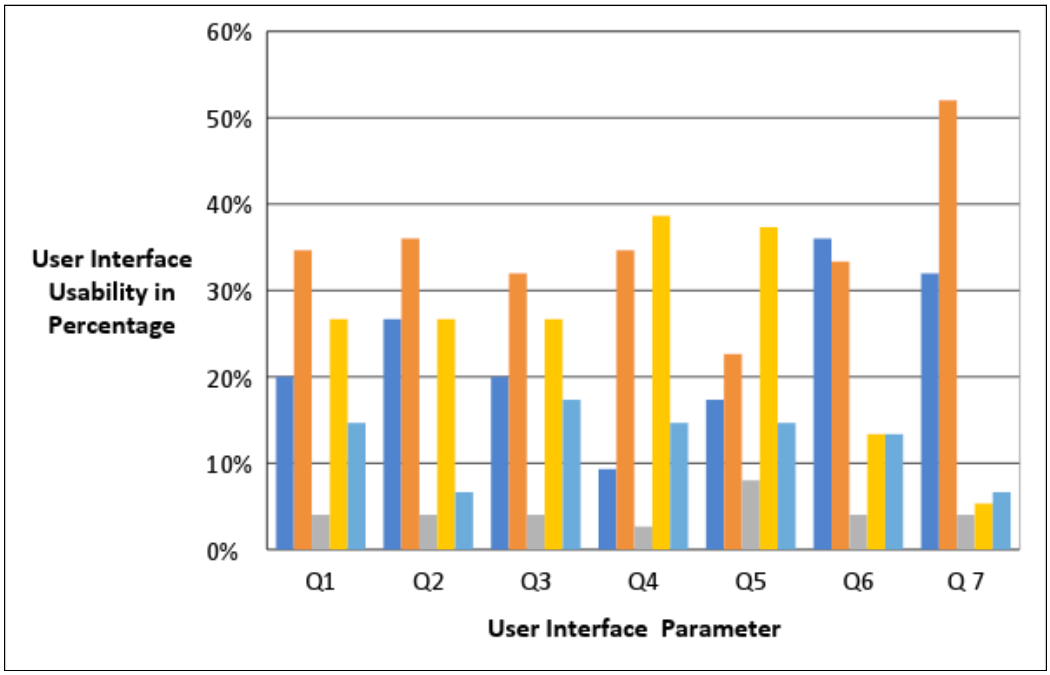

Figure 3: *Students' responses on user interface usability*

The following sections provide analyses of each seven questions.

Q1. User Interface allow for easy access to information

Table 4 indicates that 15(20%) strongly disagreed, 26(35%) disagreed, three (4%) neither agreed nor disagreed, 20(27%) agreed and 11(15%) strongly agree with the statement. Findings show that the majority of the respondents 41 (55%) either strongly disagreed or simply disagreed that the existing user interface facilitated access to information for students with HI, which suggests a need to design or add new features to enhance their learning.

Q2. Configuration of voice commands, tabs, and readings in the e-learning UI are clear and harmonious for students with HI

Table 4 indicates that 20 (27%) strongly disagreed, 27 (36 %) disagreed, three (4%) neither agreed nor disagreed, 20 (27%) agreed and five (7%) strong. Findings reveal that the majority of the respondents 47 (63 %) either strongly disagreed or agreed with the statement that the configuration of voice commands, tabs, and readings were clear and harmonious for the students with hearing impairment, hence suggesting a need for a system re-design that takes into account advances in technology and their learning environment.

Q3. Screen layout and design in the e-learning UI are appropriate for students with HI

Table 4 indicates that 15 (20%) strongly disagreed, 24 (32%) disagreed, three (4%) neither agreed nor disagreed, 20 (27%) agreed and 13 (17%) strongly agreed. In other words, most of the respondents 39(52%) either strongly disagreed or disagreed with the current screen layout and design in the UI for students with HI.

Q4. Button command in the e-learning UI is clear and easy for students with HI

Table 4 indicates that seven (9%) strongly disagreed, 26 (35%) disagreed, two (3%) neither agreed nor disagreed, 29 (39%) agreed and 11 (15%) strongly agreed. The majority of respondents 40 (54 %) either strongly agreed or simply agreed with the statement that the current button command in UI was clear and easy to use for students with hearing impairments.

Q5. Easy-to-read Web pages in the e-learning UI for students with HI

Table 4 indicates that 13 (17%) strongly disagreed, 17 (23%) disagreed, six (8%) neither agreed nor disagreed, 28 (37%) agreed and 11 (15%) strongly agreed. As such, 49 (54%) of the either strongly agreed or agreed with the statement that it was easy to read Web pages in User Interface for students with HI.

Q6. Ability to read text and objects in the e-learning UI is very easy for students with HI

Table 4 indicates that 27 (36%) strongly disagreed, 25 (33%) disagreed, three (4%) neither agreed nor disagreed, 10 (13%) agreed and 13 (17%) strongly agreed. In this regard, most of respondents 52 (59%) either strongly disagreed or simply disagreed with the statement that ability to read text and objects current screen layout and design was very easy for students with hearing impairments.

Q7. Satisfaction with the current e-learning UI

Table 4 indicates that 24 (32%) strongly disagreed, 39 (52%) disagreed, three (4%) neither agreed nor disagreed, four (5%) agreed and five (7%) strongly agree that they were satisfied with the current user interface. In other words, most of the respondents 63 (84%) either strongly disagreed or simply disagreed that they are satisfied with the current user interface.

Students were further asked to indicate whether the current user interface of the e-learning system have good appearance and navigational design. This question was asked during interviews involving 45 students with hearing impairment. Responding, most of the students were not in favour of the current user interface system. They said that the system had an unfriendly appearance and navigation system. As one student had remarked:

> *When I am using e-learning system it could be difficult to control the system because the designer does not consider [the hearing impaired] users' preferences.*

Similarly, authors further explored the challenges that students face on the existing design of an e-learning user interface in their respective schools. The findings revealed several challenges. These include lack of knowledge to use e-learning system, difficulties inherent in adopting new learning environment since they are very used to the conventional classroom-learning environment, and difficulties in catching a lesson because the system does not favour student with HI. Moreover, there were no appropriate reading texts, difficulties in connecting to website/course management system, inaccessibility of course notes/materials and inaccessibility audio/video convert to text. These findings are consistent with those obtained using the questionnaire.

The questionnaire was also distributed to all three principals and 11 teachers. Participants also indicated their degree of agreement with each question on a five-point scale consisting of the following responses: *Strongly Agree (SA), Agree (A), Neither Agree nor Disagree, Disagree (D)* and *Strongly Disagree (SD).* Their responses are summarised in Table 5.

Table 5: *User Interface Usability.*

User Interface Usability	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Total
Q1	3	5	2	3	1	14
Q2	3	6	2	2	1	14
Q3	2	3	1	5	3	14
Q4	1	4	2	5	2	14
Q5	3	5	2	2	2	14
Q6	5	4	2	2	1	14
Q7	4	5	2	2	1	14

Q1. User Interface's facilitation of access to information

Table 5 indicates that three (21%) strongly disagreed, five (36%) disagreed, two (14%) neither agreed nor disagreed, three (21%) agreed and one (7%) strongly agreed. Thus, the majority of respondents, eight (57%), either strongly disagreed or simply disagreed that User Interface facilitated access to information.

Q2. Configuration of voice commands, tabs, and readings in the e-learning UI are clear and harmonious for students with HI

Table 5 indicated that three (21%) strongly disagree, six (43%) disagreed, two (14%) neither agree nor disagreed, two (14%) agreed and one (7%) strongly agreed. In short, the majority of the respondents, nine (64%), either strongly disagreed or disagreed that the configuration of voice commands, voice tabs; voice readings are clear and harmonious for students with hearing impairments.

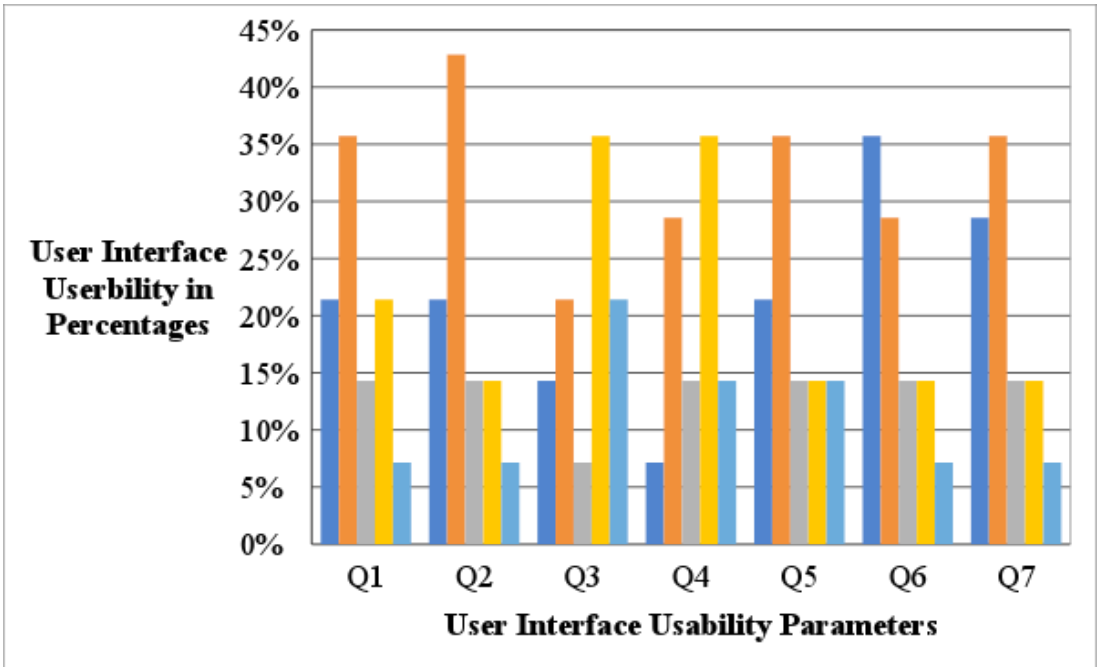

***Figure 4**: User Interface Usability.*

Q3. Screen layout and design in the e-learning UI are appropriate for students with HI

Table 5 indicates that two (14%) strongly disagreed, three (21) disagreed, one (7%) neither agreed nor disagreed, five (36%) agreed and three (21%) strongly agreed that the screen layout and design of the user interface were appropriate for students with hearing impairments. Thus, six (43 %) of the respondents agreed with the current screen layout and design in the UI as they deemed them to be appropriate for students with hearing impairment.

Q4. Button command in the e-learning UI is clear and easy for students with HI

Table 5 indicates that one (7%) strongly disagreed, four (29%) disagreed, two (14%) neither agreed nor disagreed, five (36%) agreed and two (14%) strongly agreed. In all seven (50%) respondents either strongly agreed or simply agreed that the button command in User Interface was clear and easy-to-use for students with hearing impairment.

Q5. Easy-to-read Web pages in the e-learning UI for students with HI

Table 5 indicates that three (21%) strongly disagreed, five (36%) disagreed, two (14%) neither agreed nor disagreed, two (14%) agreed and two (14%) strongly agreed. In general, eight (57%) respondents either strongly disagreed or simply disagreed with the statement that it was easy to read web pages in the user interface for the students with HI.

Q6. Ability to read text and objects in the e-learning UI is very easy for students with HI

Table 5 indicates that five (36%) strongly disagreed, four (29%) disagreed, two (4%) neither agreed nor disagreed, two (14%) agreed and one (7%) strongly agreed. Most of the respondents, nine (65%), either strongly disagreed or agreed with the ability to read text and objects in the current user interface.

Q7. Satisfaction with the current e-learning UI

Table 5 indicates that four (29%) strongly disagreed, five (36%) disagreed, two (14%) neither agreed nor disagreed, two (14%) agreed and one (7%) strongly agreed. In other words, most of the respondents nine (65 %) disagreed with the current user interface.

In summary, if the five-point scale is reduced to three points (that is, *agree, neither agree nor disagree* and *disagree)* we arrived at consistent results that an average of 44 (59%) of the students with and without hearing impairment as well as eight (57%) principals and teachers agreed that there were challenges pertaining to the mobile app, V-SOMO used in VETA institutions. This suggests a need to address the noted problems so that students particularly with hearing impairment can have easy access to education.

The next section explores hearing impairment assistive tools used in Tanzania's Vocational education institutions.

ASSESSING HEARING IMPAIRMENT ASSISTIVE TOOLS USED IN TANZANIA

The third research question sought to establish the hearing impairment assistive tools that Tanzania's vocational educational institutions use. In particular, the question was: "What are the hearing impairments assistive tools used in Tanzania?" To answer this question, the study collected data from students with hearing impairment, teachers and principals using semi-structured interviews.

i. Responses from students with hearing impairment

Findings from the study revealed that the majority of the students with hearing impairment are using personal listening devices and amplification devices. For example, one student said that:

> *I am using personal hearing aid that helps me to listen but those who are deaf cannot use them because their ears are completely defective.*

In addition, when they were asked to rate the most efficient assistive tools for e-learning user interface among the following:

> *Amplification Devices*

Telecommunication Device
Ubiduo Communication
Captioning
Voice to Text/Sign

The respondents came up with results as displayed in the bar chart (Figure 4.4), which indicates that nine (20%) indicated amplification device, three (7%) indicated telecommunication device, three (7%) cited Ubiduo Communication, seven (16%) cited Captioning and 23 (51%) indicated voice to text/sign. On the whole, the majority of the respondents preferred voice to text/sign as the most efficient assistive tool for e-learning UI as Table 6 illustrates.

Table 6: *Most efficient assistive tools*

Assistive Tools	Frequency	Percent
Amplification Devices	9	20%
Telecommunication Device	3	7%
Ubiduo Communication	3	7%
Captioning	7	16%
Voice to Text/Sign	23	51%
Total	**45**	**100%**

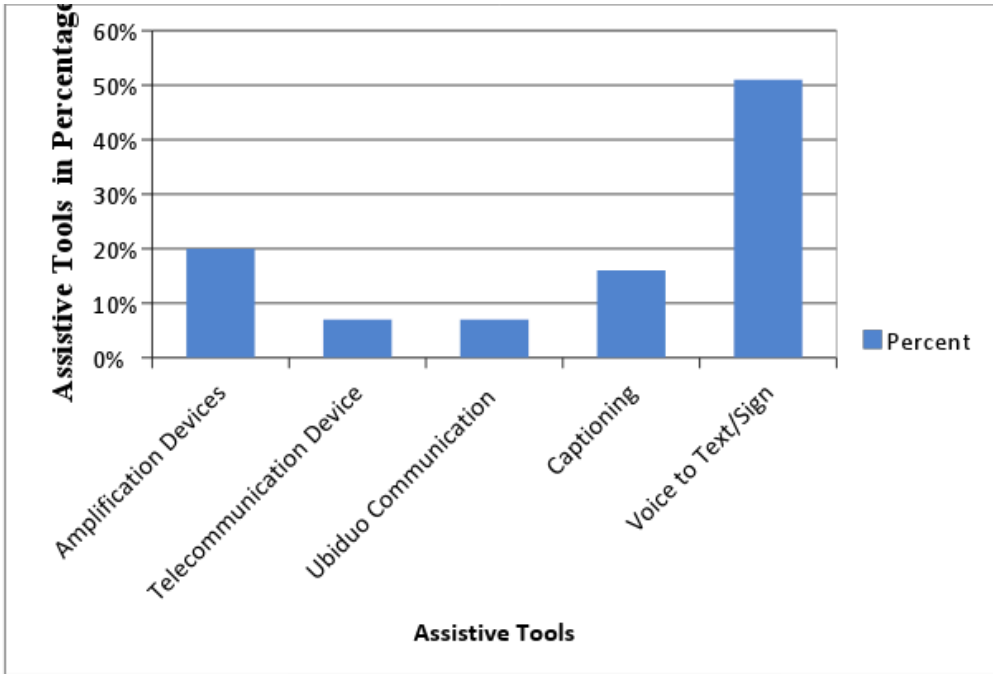

Figure 5. *Most efficient assistive tools*

It was further revealed that, most students are using basic hearing aids which have an amplifier to amplify sound coming in, a receiver, and a device for fine-tuning sound and tone. When they were further asked to mention factors that hinder the use of appropriate assistive tools in their respective schools, the respondents had mentioned factors related to cost, availability, awareness and accessibility.

In terms of cost, financial situation for the majority of the students is a major barrier to using assistive devices. Students were supposed to buy personal listening and amplification devices due to their scarcity in schools as one of respondent reported:

> *I have broken my hearing aid; I had to wait for a long time to get a new one, as I did not have enough money to spend on it.*

In addition, findings have established a problem of a severe shortage of funds for the installation of assistive technology software in the institutions involved in the study. The unavailability of assistive technology, lack of newer and quality devices were also barriers prevalent in the institutions under review:

> *If we could have voice-to-text recognition software in our e-learning system, we could have understood more easily, like students without hearing impairments but the required type of assistive technology is not available in this school, we have to buy it though it is very expensive.*

Lack of awareness about the advantages of assistive tools, lack of knowledge on modern assistive devices were also barriers the institutions faced. In fact, the majority of the respondents claimed to lack any means for getting information on the devices available:

> *An uncle told me that there were systems such as CaptiView show text on small screen that fits into the Cup-holder on the Cinema seat, which you could watch the big screen and follow the captions the little screen. But I have never seen them.*

Finally, there was a barrier of accessibility caused by difficulties in getting Internet connection with assistive device due to lack of suitable Internet. Lack of suitable network connection caused this problem, as one student pointed out:

> *Even if I have assistive device in my smartphone, I cannot access information. There is no network to access information.*

ii. Responses from teachers and principals

When teachers and principals were asked to mention assistive tools available in their schools for students with hearing impairments, their responses concurred with those from students. This set of respondents mentioned personal listening and amplification devices. They were also requested to suggest assistive tools, among the listed few, that can be used to improve the teaching and learning of students with hearing impairment in VETA institutions.

The findings show the following suggestions as indicated in Table 7: Amplification device as indicated by two (14%), Telecommunication device as cited by one (7%) respondent, Ubiduo Communication one (7%), captioning two (14%), and voice to text/sign as indicated by eight (57%). The results show that the majority preferred voice to text/sign assistive tool.

Table 7: *Suggestion on assistive tools for use in improving performance of students with HI*

Suggested Assistive Tool	Frequency	Percent
Amplification Devices	2	14%
Telecommunication Device	1	7%
Ubiduo Communication	1	7%
Captioning	2	14%
Voice to Text/Sign	8	57%
Total	**14**	**100%**

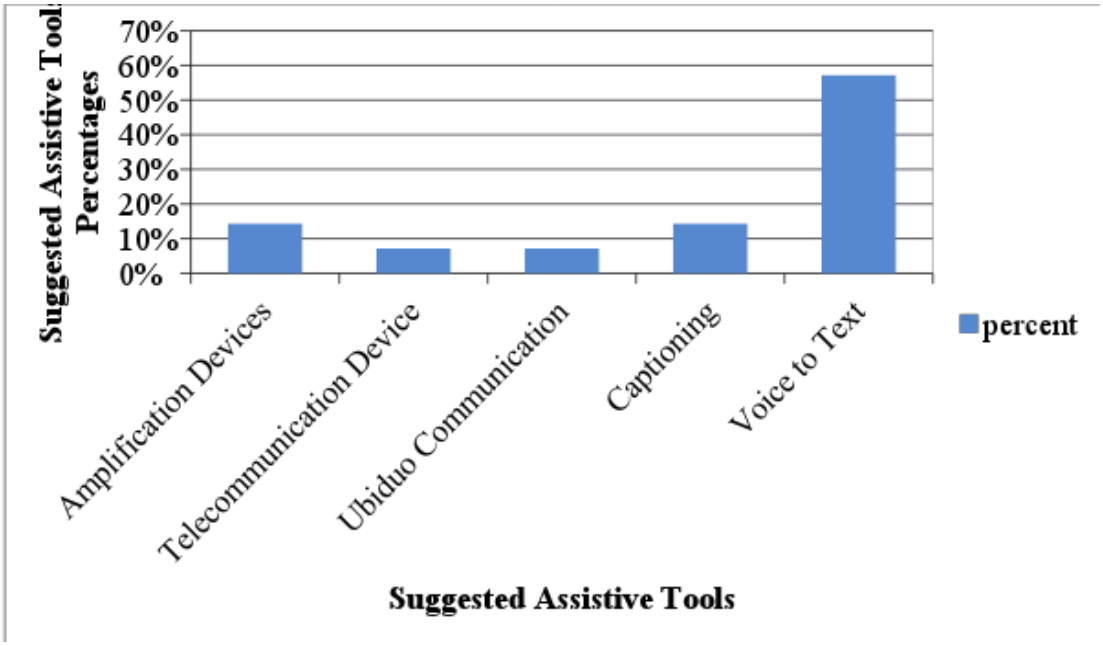

Figure 6: *Suggested Assistive Tools for Improving Academic Performance*

The authors further wanted to establish how students with hearing impairments communicate with other non-HI students. The findings show that students with hearing impairment speak facing directly the student without HI, as the face is an essential communication tool for them. They also use gestures and physical contact, writing and sign languages. Explaining one teacher said, “When I speak with students with hearing impairments, they need me to speak clearly rather than shouting.”

The authors further explored the communication strategies teachers use to communicate with the hearing-impaired students during the teaching and learning process. The respondents cited communication strategies such as lip-reading, sign language interpreters, gestures and facial expressions as well as written instructions as the one that were mostly used in facilitating instruction and learning:

> *I use a sign language interpreter with deaf students and I will always talk directly to the student and not to the interpreter to avoid creating a misunderstanding.*

Teachers were further asked to indicate whether students with hearing impairment were satisfied with using the current user interface of the e-learning system. The teacher respondents were unanimous in affirming that the students were not satisfied with the existing user interface of the e-learning system as it was not user-friendly for the students with hearing impairment. They argued that the system lacked features and assistive tools, which could assist students with HI in the learning process. In general, the existing system has poor navigation design and, thus, do not meet the needs of students with hearing impairments. In fact, the majority of the respondents suggested the application of a user interface that incorporates assistive technology, as the following statement from one of them exemplifies:

> *I suggest that learning materials for the student with HI should be visual (video/text) because they could see and, therefore, understand easily.*

In short, the analysis of the responses from students, teachers and principals revealed that the majority of the respondents preferred the voice-to-text/sign as the most efficient assistive tool for fostering e-learning UI for students with hearing impairment in the institutions studied.

It should be noted that this study used students (with and without HI), teachers and principals as sources of data for triangulation purpose. Furthermore, some questions appeared across all groups through questionnaires and interviews. Triangulation assisted the authors to corroborate findings obtained from questionnaires and interviews to provide a complete understanding of the phenomenon under investigation (Robson 2011).

Strategies to help Students with HI

The fourth research question explored what kind of strategies could come in handy in overcoming the challenges students with hearing impairments face. All the 89 participants responded to this question as shown in Table 8. Findings revealed the following strategies: To design e-learning user interface 29 (32 %), to use assistive technology 20 (23%); design a Web and mobile app for HCI 10 (11 %), to train more teachers for special need six (7%); increase computers and network seven (8%) and improve infrastructure for teaching and learning four (4%). Other results were to encourage community to send their students with HI to schools five (6%), change the mind-set of students with HI to feel with equal to others four (4%) and no response four (4%).

Table 8: *The Strategies to help the Students with HI*

Strategies	**Frequency**	**Percent**
To design e-learning user interface	29	32%
To use assistive technology	20	23%
To design a Web and mobile app for HCI	10	11%
To train more teachers for special need	6	7%
To increase computers and network	7	8%
To improves infrastructure for teaching and learning tool	4	4%
To encourage community to send students with HI to school	5	6%
To change mind set of students with HI to feel with equal to others	4	4%
No response	4	4%
Total	**89**	**100%**

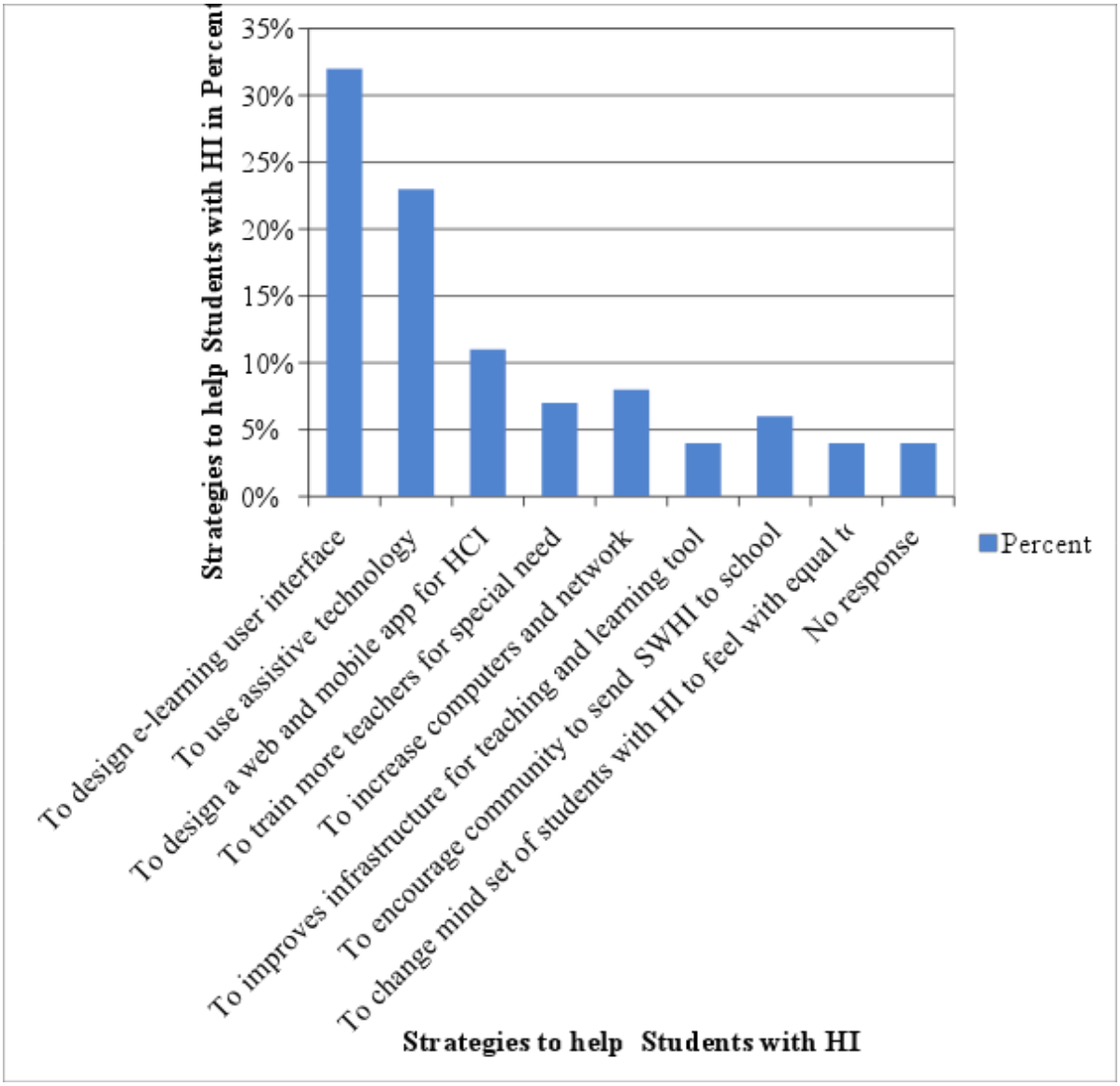

Figure 7: *The Strategies to help Students with HI*

The analysis pertaining to the fourth research question shows that the majority of the respondents called for the designing an e-learning user interface that can address the challenges undermining the existing systems so as to improve the HI students' performance in schools.

DISCUSSION

Findings show that challenges associated with *poor communication with others* were more highly cited than other factors. This outcome is consistent with findings revealed recently by Kisanga (2017). Due to problems associated with their communication disorder that students with hearing impairment face in the regular classroom environment, they tend to be afraid to express

themselves in public, which can result in their disassociating with non-disabled students (Kiomoka, 2014; Kisanga, 2017). Such withdrawal from interaction with non-disabled students goes against the principles of inclusive education and can bring about academic drawbacks and, hence, educators need to introduce some alternative solutions to addressing the situation including the introduction of appropriate assistive tools integrated with friendly e-learning user interface.

Other studies have also reported *poverty* among challenges students with hearing impairment face during the learning process. For example, NBS (2010) and URT (2015) have associated poverty with low enrolment of students with disabilities in Tanzania's primary schools in Tanzania. This is consistent with Mitra, Posarac and Brandon (2011) who contend that people with disabilities experience lower levels of educational attainment in most developing countries than the non-disabled do, which in turn increases the high level of unemployment amongst their ranks. In addition, Mitra *et al.* (2011) reports that most of the individuals with impairments including those with HI, in some developing countries, come from lower socio-economic status.

The study also found the *unfavourable appearance and navigational design* of the current user interface of the e-learning system in the institutions to constitute another hurdle affecting the effective learning of students with hearing impairments. Hashim, Tasir and Mohamad (2013) argue that an appropriate e-learning platform should factor in the needs, usability and adaptability for the students with HI to learn. The system in the VETA institutions studied had unfriendly appearance and navigation system, hence suggesting a need for an integrated system with these three salient features.

The study further revealed several challenges facing the existing design of a V-SOMO mobile app in VETA institutions. These challenges include lack of knowledge to use e-learning system, difficulties in adopting new learning environment used as they are to the conventional classroom-learning environment, and difficulties in catching a lesson because the system does not favour student with HI. Moreover, the students with hearing impairments had to contend with inappropriate reading texts, difficulties when connecting to Website/course management system, inaccessibility course notes/materials, and inaccessibility the audio/video conversion to text. The findings are consistent with those obtained by Hashim, Tasir and Mohamad (2013) and Jain, Rao and Bansal (2014) who also found problems related to poor hearing aids, uneasy access to contents on the screen and lack of special training for instructors teaching students with hearing impairments. In particular, Hashim, Tasir and Mohamad (2013) claim that teachers have inadequate knowledge in e-learning technology itself whereas students with HI find it difficult to adopt to the new learning environment.

Assessing the current assistive tools and e-learning user interface to students with hearing impairment the study has revealed some limitations established that an average of 44 (59%) students with and without hearing impairment and eight (57%) principals and teachers concurred that the current user interface used in VETA institutions presented challenges to the students with hearing impairments. For example, there were problems with hearing aids, as such devices could not distinguish speech from the noisy environment. In addition, the e-learning user interface presented accessing difficulties. The configuration of voice commands, voice tabs, voice readings were, for example, not clear and harmonious for students with hearing impairments. Moreover, the current user interface presented problems that affected the ability to read text and objects. In general, the majority of the respondents in the institutions studied were not in favour of the current e-learning user interface, hence a need to address these problems so that students, particularly those with hearing impairment can have easy access to education and hence improve their performance and reduce the dropouts among these students. In assessing the current assistive tools and an e-learning user interface to students with hearing impairment the present

study has used all participants to collect data from different perspectives and corroborate findings to enhance the validity of the data.

In summary, the analysis of the responses from the current study revealed that the majority of respondents identified the voice-to-text/sign as the most efficient assistive tool for e-learning UI among students with hearing impairment in the institutions studied. Moreover, the study findings suggest an urgent need to design a friendly e-learning user interface as a strategy for overcoming the challenges undermining the existing systems in a bid to improve the students' performance in inclusive schools.

CONCLUSION AND RECOMMENDATION

Literature has consistently suggested engaging students with disability, including those with hearing impairment, in inclusive schools. However, students with hearing impairment can be left behind if challenges associated with full access to learning are not properly addressed. Supplementing the traditional face-to-face learning with modern assistive tools integrated with proper e-learning user interface can be upon researched extensively and be used to serve students with hearing impairment and improve their learning experience and performance.

In this regard, the e-learning user interface need to have features and assistive technology that helps the students with hearing impairment participate effectively in learning and improve their performance. This is in line with the Universal Design for Learning, which necessitates incorporating multiple means of imparting and accessing knowledge for all learners regardless of their disabilities (Brokop, 2008). Features such as command for uploading video, audio, lectures and download Lectures (Streaming/Live Steaming Lectures) with sign language in user interface, which are flexible and simple to use are also crucial. The study recommends the development of a new e-learning user interface or addition of new features to the exiting platform that can boost their motivation level and improve the performance of students with hearing impairments in their learning process. These platforms should be tested and assessed for their usability and adaptability for students with HI to learn. E-learning platform with such functionalities is capable of generating friendly and interactive features by converting audio formats to textual and visual formats of the learning materials.

REFFERENCES

Ally, M. 2008. Foundation of educational theory for online learning. In T. Anderson, *The theory and practice of online learning*. pp. 16-44. Canada: AU Press, Athabasca University Press.

Almond, P., Winter, P., Cameto, R., Russell, M., Sato, E., Clarke-Midura, J. and Lazarus, S. 2010. Technology enabled and Universally Designed Assessment: Considering Access in Measuring the Achievement of the student with Disabilities. *The Journal of the Technology, Learning and assessment*. vol. 10, no. 5.

BERA (British Educational Research Association), 2011. *Ethical guidelines for Educational Research* [online]. Available at: http://www.bera.ac.uk/ [Accessed 19/01/2015].

Brokop, F. 2008. *Accessibility to e-learning for Persons with Disabilities: Strategeis, Guidelines and Standards*. Canada: eCampusAlberta and NorQuest College.

Buzzi, M. C., Buzzi, M., and Leporini, B. 2009. Accessing e-Learning Systems via Screen Reader: In Human-Computer Interaction. Interacting in Various Application Domains, pp.21-30. Springer Berlin Heidelberg.

Decman, M. 2015. Modeling the acceptance of e-learning in mandatory environments of higher education: The influence of previous education and gender. *Computers in Human Behavior*, vol. no. 49, pp. 272-281.

DPA (Data Protection Act), 1998. *Data Protection Act 1998 (c. 29)* [online]. Available at: http://www.legislation.gov.uk/ukpga/1998/29/data.pdf [Accessed 19/01/2015].

Ellen, K. 2010. *Development of an Interactive e-Learning Management System (e LMS) for Tanzanian Secondary Schools*. Blekinge Institute of Technology. Doctoral Dissertation Series no. 2010:10 School of Planning and Media Design.

Guthrie, D.M, Davidson, J.G.S, Williams, N, Campos, J, Hunter, K, Mick, P, et al. 2018. Combined impairments in vision, hearing and cognition are associated with greater levels of functional and communication difficulties than cognitive impairment alone: Analysis of interRAI data for home care and long-term care recipients in Ontario. *PLoS ONE,* vol 13. No. 2: e0192971. https://doi.org/10.1371/journal.pone.0192971

HAKIELIMU, 2008. *Do children with disabilities have equal access to education? A research report on accessibility to education for children with disabilities in Tanzania schools.* Dar es Salaam: Hakielimu.

Hashim, H., Tasir, Z and Mohamad, S. K. 2013. E-learning environment for Hearing Impaired Students. *The Turkish Online Journal of Educational Technology,* vol 12. no. 4.

Jain, P., Rao, D., and Bansal, V. 2014. Ease of e-learning for special need persons: Using e-learning utility. *International Journal of Scientific and Research Publications,* vol. 4, no. 2, pp. 1-4.

Kiomoka, D. J. 2014. *An investigation of the Challenges which Children with Visual Impairments face in Learning and Participation in Inclusive Primary Schools*. Master's Thesis in Adapted Education. Faculty of Education and Natural Science. Hedmark University College.

Kisanga, S. E. 2017. *Educational Barriers of Students with Sensory Impairment and Their Coping Strategies in Tanzanian Higher Education Institutions*, PhD thesis, Nottingham Trent University [online]. Available at: http://irep.ntu.ac.uk/id/eprint/31873/ [Accessed 10/02/2018].

Migeha, J. D. 2014. *An analysis of academic performance of students with hearing impairment in Tanzania secondary schools*. M.A thesis, The Open University of Tanzania.

Mitra, A., Posarac, A. and Brandon, B. 2011. Disability and Poverty in Developing Countries: A Snapshot from the World Health Survey. *Social protection and labour:* The World Bank.

NBS (National Bureau of Statistics), 2010. *Tanzania 2008 Disability Survey Report*. Dar es Salaam: Ministry of Health and Social Welfare.

Okkolin, M. A. 2013. *Highly educated women in Tanzania: Constructing educational wellbeing and agency*. JYVASKYLA, University Library of Jyvaskyla.

Olson, J. 2011. *An Analysis of E-Learning Impacts and Best Practices in Developing Countries With Reference To Secondary School Education in Tanzania*. The ICT$D Program, 209 Communication Arts and Science Build. Michigan State University.

Olusanya, B. O. 2007. Correction: Addressing the Global Neglect of Childhood Hearing Impairment in Developing Countries. *Plos Medicine*, vol. 4, no. 6, pp. 203-1135.

Ramma, L., & Sebothoma, B. 2016. The prevalence of hearing impairment within the Cape Town Metropolitan area. *South African Journal of Communication Disorders*, vol. 63, no. 1, a105. http://dx.doi.org/10.4102/sajcd.v63i1.105

Robson, C., 2011. *Real World Research: A Resource for Users of Social Research Methods in Applied Settings*. 3rd Ed. United Kingdom: John Wiley and Sons Ltd.

Stephanidis, C., Akoumianakis, D.,Sfyrakis, M., & Paramythis, A. 1998. *Universal accessibility in HCI: Process-oriented design guidelines and tool requirements*. Institute of Computer Science, Greece.

TFDPO, 2010. *National disability mainstreaming strategy: Towards an inclusive nation*. Dar es Salaam.

Thorne, P., Holt, E., Sanders, M., Houghton, N., Dewes, O., McCool, J., & Kafoa, B., 2016. *Estimated Incidence and Prevalence of Hearing Loss and Ear Disease in Pacific Island Nations*. New Zealand: University of Auckland and Fiji National University
.

Tungaraza, F. 2012. Inclusive education in Tanzania: Are all learners identified and their needs known? *A Journal of Contemporary Research*. vol. 9, no.3.

UNESCO, 2009. *Policy guidelines on inclusion in education, Paris: United Nations Educational Scientific and Cultural Organisations*. France: UNESCO.

UNESCO 2013. *Global Report: Opening New Avenues for empowerment ICTs to Access information and knowledge for person with Disabilities*. France: UNESCO.

UNESCO, 2012. *EFA Global Monitoring*. France:UNESCO.

UNESCO, 2013. EFA Global Monitoring. France: UNESCO.

UNESCO, 2015. Education for all 2000-2015: Achievements and Challenges. EFA Global Monitoring Report 2015. France: UNESCO

URT (UNITED REPUBLIC OF TANZANIA), 1995*. Education and Training Policy*. Tanzania: Ministry of Education and Vocational Training.

URT, 1998. *The Tanzania Development Vision 2025*. Tanzania: Planning Commission.

URT, 2012. *Primary Education Development Programme (PEDP): Phase III (2012-2016)*. Tanzania: Ministry of Education and Vocational Training.

URT, 2014. *Tanzania Basic Demographic and Socio-Economic Profile*. Tanzania: National Burea of Statistics Ministry of Finance and Ofice of Chief Government Statistician Ministry of State, President Office, State House and Good Governance

URT, 2015. *Education for all (EFA) report for Tanzania mainland*. Tanzania: Ministry of Education and Vocational Training.

VETA, 2010. *Vocational Education and Training Authority Profile*. Dar es Salaam: VETA.

Wejdan, F. & Kalpdrum, P. 2016. *E-learning User Interface for Visual and Hearing-Impaired Students*. Laurentian University, Sudbury, Canada.

WHO (World Health Organization), 2012. *WHO global estimates on prevalence of hearing loss: Mortality and Burden of Diseases and Prevention of Blindness and Deafness*

WHO, 2018. *Deafness and hearing loss*. Available at: http://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss [Accessed: 14/08/2018]

Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=2442