

Access to assistive technology among students with visual impairment in higher education institutions in Tanzania: challenges and coping mechanisms

Dalton H, Kisanga

Department of Computer Studies,
Dar es Salaam Institute of Technology, Dar es Salaam, Tanzania
Email: daltonkisanga@gmail.com

Sarah E, Kisanga

Department of Educational Psychology and Curriculum Studies,
University of Dar es Salaam, Dar es Salaam, Tanzania
Email: sarahdalton08@gmail.com

Abstract

Access to assistive technology (AT) among students with visual impairment is highly dependent on their availability and the technical know-how of the users. This study reports the challenges students with visual impairment experience in accessing assistive technology and their coping mechanisms in Tanzania's higher education institutions. The study used semi-structured interview and an open-ended questionnaire to collect data from 17 students with visual impairment and four transcribers. The resultant qualitative data was subjected to descriptive and thematic analyses. The study has identified lack of knowledge on how to apply assistive technologies, limited ICT infrastructures, and shortage of assistive technology tools as major challenges for students with visual impairment when accessing AT in higher education institutions. Two major categories of problem-focused coping—social support networks and personal efforts—emerged. The former covers support from skilled/sighted peers and institutions in terms of training on assistive technology. The latter deals with private learning through the Internet and other sources, sharing of available resources, use of smart phones, utilisation of alternative devices and borrowing of AT devices from other colleagues. Thus, the study recommends higher education institutions to provide sufficient and sustainable financial investment in AT in addition to improving their affordability to ensure that students with VI attain education equity. Similarly, students with visual impairment and their transcribers need regular training on assistive technology to enhance their accessing of assistive technologies.

Keywords: Assistive technology, higher education, visually impaired students, access to ICT, coping strategies

Introduction

At some point in life a person can either be temporarily or permanently impaired forcing someone to experience increasing level of difficulties as disability takes its toll (WHO, 2011). The World Disability Report (WHO, 2011) estimates that more than one billion people globally live with some form of disabilities. In fact, this number keeps on growing as people age. In this era of digital inclusion and globalisation, many people with disabilities and the elderly need assistive devices to remain productive and work independently (NCD, 2016; G3ict, 2017; UNESCO, 2019). A recent World Health Organisation (WHO) report shows that more than one billion people in the world require Assistive Technology (AT), with the

number projected to soar above two million by 2050 (WHO, 2016).

The need of AT is influenced not only by the nature and severity of the disability but also the ageing process. This implies that people who need AT will mostly include those with disabilities, older people and those suffering from chronic or non-communicable diseases (G3ict, 2017; UNESCO, 2019). In this regard, studies indicate that with AT people—with and without disabilities—could enjoy productive and independent lives, thus reducing support services from the society, long-term care, exclusion and dependency on family members (Silman et al., 2017; Senjam, 2019; UNESCO, 2019; WHO, 2011). To people with disabilities, AT devices help them cope with academic and social barriers resulting from societal failure to respond to their diverse needs (Kisanga, 2019). Students with VI require assistive technology to remain engaged not only with educational activities but also with the digital world. Through assistive technologies, the ability to learn, communicate, and be informed about world events as well as retrieve relevant information becomes possible. However, challenges to accessing ATs can hinder the realisation of each of these activities.

Several studies have been conducted on assistive technologies in education for students with VI originate outside Tanzania (Ampratwum *et al.*, 2016; Kapperman & Sticken, 2002; Kelly, 2011; Oira, 2012; Douglas *et al.*, 2011; Johnston *et al.*, 2009) and those that originated from Tanzania focused on teaching and learning and barriers to and coping strategies in inclusion settings (Mwakyeya, 2013; Kiomoka, 2014; Matonya, 2016; Kija, 2017; Kisanga, 2019). Ampratwum *et al.* (2016) explored barriers to the use of computer assistive technology among students with VI in Ghana whereas Kisanga, et al., (2018) examined assistive technology tools and e-learning user interface in Tanzania's vocational education institutions. Thus, there is limited empirical investigation on the challenges to access assistive technologies among students with VI in higher education in Tanzania.

Despite the advancements in enhancing opportunities for accessing education in Tanzania, students with VI continue to face educational challenges when it comes to getting meaningful learning and effective participation in their learning process, hence making the need to access ATs inevitable. The present study, therefore, sought to explore access to ATs among students with VI in higher education institutions in Tanzania. Two research questions guided the study:

- i. What challenges do students with VI face when access assistive technologies/devices?
- ii. How do students with visual impairment in higher education address these challenges experienced?

Literature review

Assistive technologies as a human right

The access to assistive technology for persons with disabilities is a human right just as access to medical or other health services, and education (WHO, 2015; UN, 2006; NCD, 2016). Article number 9 of the UN convention stipulates that access to ICT enhances not only access to education, work and independency but also serves a vital tool for managing social barriers in society (UN, 2006). Thus, governments need to prioritise AT in their budgets as without AT, persons with disabilities could hardly achieve their potentials and become productive in their work areas. This implies that, AT enhances the realisation of several human rights for persons with disability including the right to education, health services and employment.

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In this regard, WHO has identified assistive technology as one of the six global priorities aimed to enhance accessibility to high quality and affordable assistive products (WHO, 2011). Thus, governments throughout the world, needs to accord AT the attention it deserves for people with disability including those with visual impairment to participate in and contribute to the society on equal basis.

Assistive technology in education

Assistive technologies have helped to enhance the skills of the people with visual impairment in the US, the UK, and other European countries (Lanyiet *al.*, 2012; Noemi & Maximo, 2014). The use of AT in the classroom plays an active role in fostering the learning process has become an integral part of the classroom learning environment for both developed and developing countries. In North America, AT has become a “tool of choice” for enhancing the educational experience for persons with learning and visual disabilities and the entire students' population (Edyburn, 2004a; Koch, 2017; Boucher, 2018). Assistive technologies help developing enhanced learning as well as ability for self-expression and communication. Many disabled individuals want to communicate but cannot express these effectively. Many of these so-called “e-inclusion” technologies are allowing for that communication to be possible (WHO, 2015b; Koch, 2017; Boucher, 2018).

Assistive technologies also help persons with visual impairment in enhancing the accessibility of electronic materials and examinations, increasing the trustworthiness of students' work, widening employment opportunities, and reducing over-dependence (Argyropoulos & Thymakis, 2014; Douglas et al., 2011; Kisanga, 2019; Kisanga & Kisanga, 2020; Silman, Yaratana & Karanfiller, 2017; WHO, 2016). In addition, assistive technology assists people with visual impairment in handling academic and social matters as well as channelling the course of their career. In this regard, the American Foundation for the Blind (AFB 2012) established that, AT to be a useful resource in assisting persons with disabilities to do things more quickly, easily and independently. In education, AT equips teachers with innovative tools to help students with VI and others with special education needs to manage the barriers that impede their teaching and learning process (Oira, 2016). Indeed, in this inclusion era, students with visual impairment and those with special education needs require AT to be able to interact with their teachers, students, and education materials (Senjam, 2019; WHO, 2011).

Challenges to the accessibility of assistive technology

Despite the increasing need of AT among people, its accessibility appears to be omitted in educational infrastructure; consequently, only few have accessibility to them. The World Health Organisation provide an estimate of about 10 percent of all the people who needs AT worldwide, have access to them (WHO, 2016). Literature have documented limited access of AT to people including students with disabilities both in developed and developing countries (Kelly, 2011; Ampratwum, Offei & Ntoaduro, 2016; WHO, 2016). Kelly, (2011) claims that in the US, less than 40 percent of the students in elementary and middle schools have access to assistive technology. Similarly, a report by G3ict (2017) show that many nations have limited accessible infrastructure such as digital libraries and assistive technologies. This suggests that the situation in developing countries and particularly Tanzania is worse in developed countries due to low levels of technology and unreliable power supply.

Different factors are associated with limited accessibility to AT including lack of knowledge to use assistive devices, limited availability of assistive devices, inadequate

financing, high cost, lack of experts and technical staffs, lack of assistive technology policy (Ampratwumet *al.*, 2016; Kelly, 2011; Oira, 2012; UNESCO, 2019;WHO, 2016). Regarding the AT Policy, many countries in the world have reported lacking assistive technology policy (WHO, 2016). Consequently, the responsibility of purchasing assistive devices is left to the users and their families creating a burden to those from poor families.

Regarding knowledge on using AT, some students with VI were reported to lack knowledge on using computer assistive technology (Ampratwumet *al.*, 2016) suggesting that they are often not aware of the potential of ATs to enhance education. It was reported that 95 percent of students experienced challenges on using screen reader called Job Access With Speech (JAWS) and keyboard on the computer (*ibid.*). Students could not identify some keys on the keyboard because arrangement of alphabet does not follow usual arrangement of alphabet from A to Z. The students further experienced challenges on using JAWS because the school used unlicensed application limiting access to other applications (Ampratwumet *al.*, 2016). Also, some students reported difficulties in voice recognition because the pronunciation used was unfamiliar to them.

Methodology

This study was conducted in one public higher learning institution in Tanzania labelled the *public institution*, as it not mentioned to protect its identity. Purposive sampling was used to select the institution under review. The institution was studied because, first, it has long experience in supporting students with special education needs in Tanzania (Kisanga, 2017; Tungaraza, 2012) and, second, it has more students with visual impairment (38) than other higher education institutions. Similarly, all the 37 students with visual impairment available in the selected public institution were invited to participate in the study. However, only 17 students agreed to participate in the study. The study also involved four transcribers who work at the special education unit to support students with visual impairment in academic matters making a total of twenty-one participants.

The study used an open-ended questionnaire and semi-structured interviews to collect information from the respondents. Most (17) opted for open-ended questionnaires whereas others (4) preferred semi-structured interview. Students with VI, who responded to the open-ended questionnaires, used assistive technology to download, respond and send back to the researchers either on their own or using personal assistants. Semi-structured interviews were dictated by the question of convenient date and time of the respondent. The interview took about an hour and were conducted at one of the researcher's office. This study adhered to all ethical issues: informed consent, anonymity, and confidentiality to name the few (Cohen, Manion & Morrison, 2011). Students with visual impairment are referred to as *St 1 to St 17*, transcribers are referred to as *Tr 1 to Tr 4* whereas TB is used to mean *total blind*, LV as *low vision*, UG as *undergraduate* and PG as *postgraduate*.

This study used two methods to analyse its data. Descriptive analysis covered frequencies for the data collected, especially in establishing which challenge the respondents frequently mentioned. Thematic analysis, on the other hand, helped to generate themes and sub-themes from the respondents' data in accordance with the objectives of the study (Braun & Clarke, 2006; Clarke & Braun, 2013).

Study results

Challenges to using assistive technologies in higher education

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The first research question attempts to identify the challenges to the use of assistive technologies in higher education. Participants, in this regard, were required to respond to the questions, “Do you experience any challenge when using assistive technologies/devices? What are those challenges?” Data were collected from all the participants. The findings revealed eight (8) factors as summarised in Table 1:

Table 1: Challenges to using Assistive Technologies

S/N	Challenges of using assistive technologies: emerged themes	Frequency
1	Lack of knowledge on how to use assistive technologies.	8
2	Limited ICT infrastructure	2
3	Shortage/limited number of Assistive Technology tools	4
4	Absence of experts or technical assistance	3
5	Most assistive technology devices are not customized to suite our environment.	2
6	Lack of culture of maintenance of Assistive technology tools	5
7	High cost associated to some assistive technology tools	2
8	Technophobia (Phobia of technology)	3

Lack of knowledge on how to use assistive technologies

The study identified the major challenge to using ATs as lack of knowledge among both students with visual impairment and their transcribers, as reported by 8 out of 21 participants, who insisted that limited knowledge on the use of AT devices was a hurdle for most of these students with VI. Moreover, some staff employed to assist learning for students with VI as remarked by St8 also faced this challenge:

I have limited knowledge in using ATs and some staff [transcribers] have little knowledge as well, hence making life more difficult (St8, Female, UG, TB).

Limited knowledge has also prevented students with VI in the institution under review to use electronic note-takers offered to them more than seven years ago because neither the students nor the faculty could use the devices. The limited knowledge revealed from the study suggests that, for students with VI to benefit from AT, they need to be equipped with appropriate training.

Limited ICT infrastructure

Limited ICT infrastructure was reported by 5 out of 21 participants to be a barrier to using ATs in higher education. Other barriers reported by the respondents include erratic power supply, low internet connectivity, and outdated technological devices. These impediments were reported by both students and transcribers in equal measure. Regarding power failures, the respondents explained that power supply was largely erratic especially in the building providing support to these students. It was also reported that, there is no alternative source of power such as solar system, gas generated power, or emergency electric power generators, hence making the use of AT even more daunting. This situation suggests that even with appropriate knowledge among users, there is a need to ensure that ICT-supportive

infrastructures such as power supply and internet connectivity were readily available to enhance the use of ATs in education institutions.

Shortage/limited number of assistive technology tools

Shortage number of ATs relative to the number of students with VI was also reported as a challenge. There are few technological devices available at the special unit, hence forcing it to restrict the use of some of them, as S3 explained:

Due to the shortage of some AT devices, there are restrictions imposed by the Special Education Unit on using some devices, such as computers. The unit provides us with access to computers during examinations and not for private studies because it has too limited a number of computers to cater for all the students with VI. For an effective teaching and learning process, I suggest students with VI to use any AT if it enhances academic performance (St3, Male, PG, TB).

This statement illustrates the shortage of computers students with VI in higher education experienced. Indeed, students cannot use ATs effectively if they do not have access to crucial devices such as computers, which enhance the utilisation of AT.

Absence of experts or technical assistance

Further analysis revealed the absence of enough numbers of experts to support ATs as another challenge to the use of assistive technologies that students with VI countenanced. For example, students claimed that, sometimes they could not get support from their transcribers because they also lacked knowledge on the application of some ATs. It was observed that most of the functions in some ATs cannot be accessed by screen readers and, thus, missing their talkback. In fact, some screen-touch operations on the computer and smart-phones are not integrated in the screen reader, thus limiting the interaction with the device for persons with VI. Furthermore, the absence of experts may subject students to high risk of downloading virus and, hence, damage their gadgets.

The study findings also show that most assistive technology devices are not customised to suit the user-needs of students with VI. For example, students with VI reported that some Non-Visual Desktop Access (NVDA) and talkback applications have no human voice and those which do cannot pronounce well the text written in KiSwahili language, which they pronounce in English tones. Also, findings show that some ATs cannot access graphics as reported by St1:

Some assistive technology cannot access graphics, scanned documents, and other software components. For instance, it is impossible to edit video in Open Shot or Adobe Photoshop using NVDA as open shot or Adobe Photoshop features are not pronounced by NVDA (St1, Male, PG, TB).

In support of this view, St3 said:

Some ATs, such as screen readers, are incapable of accessing some websites simply because of the unfriendly and inaccessible format of the information slotted in such websites (St3, Male, PG, TB).

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The statement implies that not all screen reader technologies have abilities to access every electronic information. This suggests that, with limited access to modern ATs it is difficult to achieve full independence in accessing AT for people with VI.

Lack of culture of maintenance of assistive technology tools

The analysis also found that some equipment in the institution under review were not functioning properly due to lack of regular maintenance. Two major factors emerged causes: Lack of financial support to repair assistive technology tools or negligence; and lack of a culture of maintenance. For the former, it was surprising for education institutions to have various non-functioning education resources over a long period when it is relatively cheaper to repair them than to buy brand new ones. For the latter case, the culture of maintenance should be inculcated among educational authorities with a special budget set aside for that.

High cost associated with some assistive technology tools

Some respondents have reported high cost of assistive devices as among the major barriers for persons with VI to access AT. It was reported that most of the assistive technology and devices are expensive for a student with VI to afford. For example, the Braille note-touch was reported to be a useful assistive technology; however, only one student among the 17 involved in this study owns the device. The device costs about **US\$ 5500** (American Foundation for the Blind [AFB], 2016), an equivalent of **TZS 12,650,000/=** in local currency, an astronomical price-tag for an ordinary student. This student, who had the Braille note-touch in the institution under review, happened to have received it from a sponsor. Perhaps, the exorbitant cost of Braille note-touch prevented the institution under review to buy even few devices in the special unit.

Technophobia

Further data analysis regarding this research question produced surprising results to the effect that some students, due to unknown reasons, are not ready to adopt the new technologies available at the university or on the internet. Other students despite having benefited from training on the application of assistive technology were not ready to do their university examination on AT-equipped computers. Those few students still use typewriters during tests and examinations. One respondent explained this situation thusly:

You know what I do not want to add extra pressure during an examination. The examination itself presents adequate tension; using computer means adding tension and I am not ready for that (St15, Female, UG, TB).

This statement implies that some students with VI doubt their ability to perform when using ATs. This suggests that they have either limited knowledge on ATs application or they have poor self-efficacy.

Strategies used to address challenges students with VI

The final research question explored the strategies deemed favourable for addressing the observed challenges. In this regard, the respondents were requested to answer the question,

“What strategies are used to address the challenges students with VI experienced?” All the participants responded to this question. Table 2 presents the results:

Table 2: Strategies used to address the challenges

Strategies to address the challenges	Strategies used to address the challenges: <i>Verbatim quotations</i>	Respondent
Strategies on limited knowledge on ATs	Regarding lack of adequate AT knowledge, we as persons with VI have been sharing the little knowledge we have, for instance through social medias.	(St3, Male, PG, TB).
	I have been reading internet sources on ATs whenever I need certain AT related information	Tr2
	I tried to socialise with others who know, and, on some occasions, I request assistance from some skilled colleagues	St8, Female, UG, TB
	The assistant can read for me; Learning and copying some skills from friend and media; Borrow computer from friends for reading.	(St13, Female, UG, M, LV)
	I keep on learning how to use the functions that I am not aware of and, sometimes, I ask for assistance from a non-visually impaired person.	St14, Male, PG, TB)
	Motivate students to use computers in their regular use	(Tr3, Female, BD)
Strategies related to ICT infrastructure	Conduct computer training for students with VI every new academic year	Tr3, Female, BD) (Tr4, Male, BD)
	Advise the authorities to solve the erratic electrical power supply problem	(Tr4, Male, BD)
	I use my experience to address the challenge in collaboration with my colleagues	Tr1, Male, MA) (Tr3 Female, BD)
Strategies related to number of Assistive Technology tools	In the case of internet connectivity, I will make sure that I find the right location that could facilitate connectivity for accessing online materials	St5, Female, PG, TB)
	Sharing available resources. Proper arrangement is applied to equip students with technologies available e.g. We can decide, say, to give certain equipment to first years only	(St11, Male, UG, TB) (Tt1, Male, MA) (Tr4 Male, BD),
Strategies related to expert or technical assistance	I will keep on learning how to use the functions that I am not aware of and sometimes I will ask for assistance from a non-visually impaired person.	St14, Male, PG, TB)
Strategies	Learning gradually the way it pronounces KiSwahili	(St1, Male, PG,

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related to	texts in English	TB)
challenges experienced in screen readers pronunciations	Listening attentively to screen readers. When I am bored, I rest or use Braille. Whenever screen readers fail to access some information, human readers are employed. Using sighted friend to access inaccessible information.	St1, Male, PG, TB) (St3, Male, PG, TB) (St1, Male, PG, TB)
Strategies related to the culture of maintenance of Assistive technology tools	I will make sure of reporting to the staff so that they could enforce the programme that could assist in the maintenance of such AT devices.	(St5, Female, PG, TB)
Strategies to address High cost associated to some assistive technology tools	Borrow a computer from friends for reading To have a Smartphone for daily interaction with relevant tools	(St13, Female, UG, LV) (St10, Male, UG, LV)
Strategies to address technophobia	Conduct awareness training for students on how to use new technological devices Promoting awareness on the importance of students with VI using ATs	(Tr3, Female, BD) Tr4, Male, MA

Strategies for addressing limited knowledge on assistive technology

Training on assistive technology

Training emerged as a key strategy for students with VI in a bid to address the challenge of lack of knowledge to use assistive technologies. Specifically, two types of training stood out: Formal and informal. Formal training is organised by the institution's Special Education Unit for students every new academic year:

We normally expose students with VI to computer training every new academic year for a duration of about 2-3 weeks to orient them on ATs and ICT (Tr3, Female, BD).

Although the students are equipped with AT training, the duration of the training was reported to be too short to cover all the relevant and salient topics. This suggests that most of the relevant topics remained uncovered as a result. Further analysis shows that, most of the taught topics range from Introduction to Personal Computers and Windows up to the use of Microsoft Office applications. For example, when responding to the question, "Do you have adequate knowledge and skills on how to use assistive technology/devices?", five out of 17 student respondents reported lack of training on the use of ATs. Thus, only 12 students attended training. Similarly, six out of 12 who attended the training reported that they did not acquire the expected knowledge due to short training duration. Thus, most of them would opt

for an alternative strategy that is informal training. Findings show that, students would either request support from a skilled colleague during informal training:

I socialise with others who know and in some occasions I request for assistance from some skilled colleagues” (St8, Female, UG, TB).

Other respondents demonstrated a self-learning behaviour using various sources including the Internet as St3 commented:

Regarding lack of adequate AT knowledge, we as persons with VI have been sharing the little knowledge we have, for instance through social medias. Moreover, I have been reading internet sources on ATs whenever I need certain AT related information (St3, Male, PG, TB).

As St3 said that sharing of information through social media among students with and without VI has been useful and practical. In addition, transcribers have always motivated students to use computers on regular basis.

Strategies related to ICT infrastructure

The study also identified three potential infrastructural problems. These are unpredictable electric power supply, the existence of outdated technological devices, and slow Internet connectivity. The remedial measures students employed depended on individual experiences and the environment. Some reported seeking support from colleagues whereas others moved to the location with strong wireless network signals for easy Internet communication/learning. In this regard, one respondent said,

For the case of internet connectivity, I will make sure that I find the right location that could facilitate access to online materials” (St5, Female, PG, TB)

As for the unreliable electrical power supply, the Special Education Unit has already reported the case to the central University authority for action to have either a standby generator or alternative source of power such as solar system.

Strategies related to limited number of assistive technology tools

Further analysis on strategies revealed that students with VI share the few available assistive devices at their disposal. They reported that, those few with certain assistive devices, which were not available at the special unit, shared with the others. Similarly, the Special Education Unit staff have an arrangement on how to use the limited assistive devices such as computers as testified by one of transcribers that “we can decide say to give certain equipment to first years only” (Tr1, Male, MA). One of the criteria used in this strategy is to consider those who are in need most. Notably, most of the students with VI in higher education in Tanzania begin using computers when they reach higher education. Due to the limited number of computers in the institution under review priority is given to first-years to assist them during assistive technology training. Other students are encouraged to buy their own devices using their stipend or personal sponsors.

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Strategies related to shortage of experts or technical assistance

Another challenge reported in this study was limited number of assistive technology experts as well as lack of technical assistance when needed. Students with VI addressed this challenge using two major strategies: First, some respondents reported persisting to learn how to use certain AT functions until they become competent in applying them. Second, students with VI reported that they received support from sighted people (see Table 2). Indeed, support from sighted students was found vital not only to dependent users of AT, but also to independent users when they encountered technical problems.

Strategies related to challenges experienced in screen readers' pronunciations

Some students with VI experienced difficulties in understanding pronunciations on screen readers because they are not customised to suit their needs, especially the language of the user. To overcome this challenge, some students said they continued learning gradually to master how the devices pronounce KiSwahili texts in the English tone until they got used to the alien pronunciation. Some students when facing pronunciation challenges opted to use Braille so that they would learn by a sense of touch and not hearing. Other students reported seeking assistance from the human readers or sighted colleagues to overcome such a challenge.

Strategies to manage high cost associated to some assistive technology tools

Students with VI managed this challenge by using alternative devices/means which could provide them with the same output. For example, failure to buy a Braille note-touch made students use education materials in Braille format and electronic format using screen readers to access them on their computers. Moreover, findings reveal that students would either borrow computers from their colleagues to search certain education materials on the internet or type certain academic work. Other students reported relying on their smartphones for daily interaction with relevant tools (see Table 1). For qualification purposes, all these strategies on the high cost of assistive technology originated from the students with VI based on their on-campus experiences rather than from the education authorities.

Strategies to address technophobia

Transcribers involved in this study concurred that those who were reluctant to use certain assistive devices had either limited knowledge on ATs or were not confident enough in their ability to use ATs. In this regard, the Special Education Unit makes special arrangements aimed to create awareness through training to promote the use of ATs among students with VI and expose them to different ATs available to minimise, if not eradicate, the education challenge they faced.

Discussion

Findings from this study revealed lack of knowledge on how to access assistive technologies as a major barrier. About eight participants reported facing challenges when using AT due to limited knowledge. This finding is consistent with UNESCO (2019), WHO (2011) and Ampratwunet *al.* (2016). WHO (2011) found that people with disabilities, including those with VI, have limited access to and awareness of the assistive device benefits. Similarly,

UNESCO's (2019) Digital Access to Information and Knowledge for Persons with Disabilities report revealed low awareness on the huge potentials of AT in enhancing education for students with VI. In fact, lack of knowledge is evident among students with VI due to their over-dependency on sighted peers and readers when applying some of the ATs (Kisanga & Kisanga, 2020).

Apart from low awareness on ATs, the study also established scarcity of ICT infrastructures. Consistent with UNESCO (2019) as well as Kisanga and Ireson (2015), it is evident that there are still ICT infrastructural problems facing higher education institutions that need to be addressed for students with VI to learn and participate effectively. This is a global phenomenon as many developing nations have inadequate ICT infrastructures that could facilitate and scale up the use of ATs (UNESCO 2019). On the other hand, when the ICT infrastructure is offered such as computers with a screen reader, the study findings indicate that they were in such a short supply that they could not satisfy the needs of the entire population of students with disabilities, let alone those with VI.

Despite these challenges, the present study has established that some AT devices available are not customised to suit their environment. In some cases, access features on available are underutilised as they are not integrated with voice. Indeed, some on-screen touch operations in the computer are not integrated in the screen reader and, thus, students with VI had to contend with limited interactivity on the device. These results are consistent with the NCD (2016) report, which found access features to some ATs to be underutilised by people with disabilities. Other challenges include lack of a culture of maintenance coupled with high cost associated with assistive technology tools.

These challenges notwithstanding, the study also found the students with VI had recourse to the use of problem-focused coping strategies to ease the problems. These strategies are *social support networks* and *personal efforts* (Kisanga 2019). Lazarus (1993) defines problem-focused coping mechanisms as strategies that act directly on the problem to solve it. In this study, *social support networks* and *personal efforts* strategies were employed interchangeably depending on the nature of the problem they faced at a given time. For example, when addressing the problem of lack of knowledge, both individual (personal effort) and institutional (social support effort) came into play. Individual effort, especially informal training, was necessary because the formal training offered was not adequate enough to equip students with the expected skills due to its short duration. Regarding problems related to ICT infrastructure, some students seek support from colleagues whereas others move to the right location to receive strong signals for Internet connectivity communication/learning, indicating that there is no effective institutional mechanism to address the challenge. As for the limited number of ATs, sharing was the norm as those few with ATs allowed others to access them, with priority given to those who needed them most. Those, who were well-off, were encouraged to buy their own devices.

To address the problem of the shortage of expertise or technical support, students with VI spend more time seeking opportunities to improve their knowledge through individual efforts or by getting support from sighted people. Through individual effort students further address problems related to un-customised ATs. Moreover, students would learn gradually how some devices pronounce Kiswahili texts in the English tone until they get used to the rather alien pronunciation. The finding is consistent with Ampratwum et al. (2016) who found that students with VI to keep on listening pronunciations until when they become familiar. Contrary to the present study, students in Ampratwum et al.'s (2016) study were encouraged by the teacher who "always encourages them to listen carefully to the speech of the JAWS in order to become familiar with the voice" (p. 60) whereas in the present study it was largely through a personal effort. As for strategies aimed to address the question of the high cost

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associated with some assistive technologies most of the students either use alternative devices producing the same output or share the limited devices at their disposal. In addition, students with VI use smartphones with integrated screen reader technology for both learning and communication purposes.

In short, the comments made by respondents provide empirical evidence to the effect that there are challenges to AT usage among students with VI in the institution under review. Moreover, the strategies used to address the three major challenges—lack of knowledge, limited ICT infrastructures, shortage of AT tools—suggests either low education budget in higher education institutions in Tanzania or lack of institutional priority in meeting the needs of students with VI in these organisations. In fact, most of the strategies employed were personal rather than social support efforts.

Conclusion

The present study has shed light on the challenges that the students with visual impairment face in accessing assistive technology and their coping mechanisms in higher education institutions in Tanzania. The three key challenges established by this study are lack of knowledge, lack of infrastructure, and shortage of experts well-versed in ATs. The first challenge of lack of knowledge on how to access assistive technologies among students with VI appears to be pervasive and need an urgent solution. The second has to do with related to ICT infrastructure mostly in terms of Internet connectivity continues mainly due to the use of outdated digital devices and erratic power supply. However, this has improved from what was the case a decade ago when the rather limited ICT infrastructure significantly affected learning in education sector in Tanzania. The submarine optic fibre cable and 4th generation mobile network technology has engendered fast wireless Internet connectivity in Tanzania's higher education institutions, hence creating necessary conditions for overcoming limitations in education effectively.

On the other hand, the study recorded different strategic measures students with visual impairments apply to address these challenges. It appears the onus of addressing these challenges is left for students rather than the institution, which explains why most of the strategies applicable in the study area originated from the students rather than from the authority. Yet, to ensure students with visual impairment benefit from education provided and achieve equity in education, appropriate and effective training need to be provided to improve the students' confidence and skills for them to learn and participate effectively in the education process. Furthermore, the government needs to commit itself to establishing adequate infrastructure and providing sustainable funding for assistive technologies in addition to ensuring that students with VI benefit the same standard of education as their peers without disabilities.

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