Global Scientific JOURNALS

GSJ: Volume 9, Issue 2, February 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Availability of Assistive Technology Devices for Students with Visual Impairment: Evidence from the University of Cape Coast

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Abstract

It is imperative to note that assistive technology allows individuals with visual impairment to overcome a major part of the difficulties in their daily lives and offers them independence and autonomy in their education and access to communication, just like their peers with vision. Several studies have shown that assistive technology has advanced and has positively influenced the lives of persons with disability especially in the area of education. This made the researcher to assess the availability of assistive technology devices for students with visual impairment from the University of Cape Coast. The study was nested into the qualitative interpretive phenomenological methodology using a case study design. The study revealed that assistive technology available to students with visual impairment are Perkins Braille, Braille embossers, scanner, closed circuit- television (CCTV) and finally computers installed with speech reader (JAWS- Job Access with Speech). These devices at the Resource Centre for Alternative Media and Assistive Technology are mainly auditory-based technologies and computer magnifiers that assist students with visual impairment in their academic work. The Perkins braille and the hand frame were considered by visually impaired student as outmoded devices. From the viewpoints of the students, the usage of the Perkins braille and the hand frame did not only retard their exposure to modern technology. Provide ample resources that support visually impaired student's development in area of reading, writing, mathematics and mobility. See to it that old assistive technologies are replaced with the modern technologies trending in the education of visually impaired persons.

Keywords: Availability, Assistive Technology Devices, Students, Visual Impairment, University of Cape Coast

Introduction

Globally, an estimated 40 to 45 million people are totally blind, 135 million have low vision and 314 million have some kind of visual impairment (World Health Organisation (WHO), 2009). The incidence and demographics of blindness vary greatly in different parts of the world. In most industrialised countries, approximately 0.4% of the population is blind while in developing countries it rises to 1.0%. It is estimated that 87% of the world's blind live in developing countries for which Ghana is part. Over the last decades, visual impairment and blindness caused by infectious diseases have been greatly reduced (an indication of the success of international public health action), but there is a visible increase in the number of people who are blind or visually impaired from conditions related to longer life expectancies (WHO,

2009). In all sensations perceived through our senses, those received through sight have by far been the greatest influence on perception. Sight combined with the other senses, mainly hearing, allow us to have a perception about the world and take certain actions. Every life is defined by the unique set of challenges one must overcome, and blind people- just like their sighted peers - often need some assistance when it comes to conquering various obstacles in life. So much of our lives have become contained within a screen, the technological revolution in the next few decades would seem disastrous for the blind community, but in many respects the opposite is true. As technology has advanced so has assistive technology - devices and innovations that make the world more accessible for the disabled, and most importantly, allow them to live more independently.

There is no fixed series of events that constitute the history of the development of assistive technology. The growth and development of this technology is dotted with events beginning in the 19th century. In 1808, Pellegrino built a typewriter to help his blind friend Countess Carolina Fivizzono writes legibly. Since then, there have been periodic attempts to strengthen the assistance provided for the differently abled. The use of devices like wheelchairs, hearing aids, and various software applications like voice-assisted computers for the blind have boosted the creativity and ability of a largely dependent population. Perhaps, one of the greatest inspirations was provided by Louis Braille, who developed a language for the blind in the year 1821 (Prashant, 2011). It was not until 1892 that Mr Frank H. Hall, Superintendent of the Illinois School for the Blind, invented a Brailler that was the first to find general acceptance. More than 50 years after the machine was first produced, the Perkins Brailler continues to play a part in bringing education, literacy and independence to people throughout the world. Then around 1968 the first English text-to-speech synthesis was developed by Noriko Umeda at the Electrotechnical laboratory in Japan to convert normal language text into speech. By 1991, White Canes and Screen readers were in existence (Brabyn, Seelman & Panchang, 2007). Now, in 2016, one can talk about refreshable Braille display, currency readers, self-driven cars, smartphones, smart watches and computers which are more accessible to the blind.

Assistive technology is an interdisciplinary field of knowledge comprising products, resources, methodologies, strategies, practices, and services that aims to promote functionality for visually impaired people with regard to autonomy, independence, quality of life and social inclusion (Cook & Hussey, 2002). Assistive technology began with answering the most basic needs of the blind using computers by translating what was on a computer screen into audio, but has evolved into one of the most exciting areas of technological innovation today. Innovations in assistive technology have not always come cheap. The importance of assistive technology for human development is recognised by the Convention on the Rights of Persons with Disabilities (CRPD), which entitles beneficiaries to full and equal enjoyment of all human rights including the right to the use of appropriate assistive technology (United Nations, 2007). To comply with the CRPD, national governments should implement measures to meet citizens' needs for assistive technology, governments and international organisations with available means should provide technical and economic assistance to developing countries to access, share, and transfer assistive technology (United Nations, 2007).

Currently in Ghana, the forms of assistive technology devices used in various schools for the blind has advanced. There is a little shift from the 'frame and stylus only' usage to computers and devices with screen readers. Most developed nations are far advanced in terms of assistive technology. Ghana is also using assistive technology in our educational sector especially in the tertiary institutions. In the University of Cape Coast (UCC), a Resource Centre for Alternative Media and Assistive Technology (R-CAMAT) has been established.

The Centre, which was formally called Resource Centre for the Visually Impaired, was established in 1979/1980 academic year to give support to university students who are visually impaired. The centre started with a few Perkins, frame and stylus. The Ghana Blind Union (GBU) in October 2002 put up a model regional computer learning centre in Accra to provide blind and partially sighted persons with basic computer literacy skills in an attempt to give them fair grounds in all spheres of endeavours in Ghana and the West African sub-region in general. This was done through the implementation of a six weeks basic computer learning course at their centre. The project had the primary objective to train blind and partially sighted persons to become proficient enough to help them participate in educational and employment opportunities offered to their sighted peers (National Council on Persons with Disability, 2010).

Types of assistive devices

A paper by Sanaman and Kumar (2014) aimed to study the current status of various Assistive Technology facilities available for the people with disabilities in National Capital Region Libraries in India. Survey methodology was used as the basic research tool to collect the data with the help of questionnaire from various institutions/libraries serving the people with disabilities. A total number of 15 libraries were selected for the study. The study depicted the lack of Assistive Technology facilities in National Capital Region libraries and concluded that there is negligible amount of Assistive Technology facilities for the visual and hearing impaired and loco-motor impaired users in the institutions/libraries. There were also many libraries that did not have the sufficient Assistive Technology facilities to serve the people with disabilities. They recommended the improvement in the use of AT professionals in various libraries in India and the research community to provide an insight into the current status of the Assistive Technologies available in National Capital Region Libraries, India (Sanaman, G. & Kumar, 2014).

From the work, a lot of assistive devices were taken into consideration. It included: 'JAWS for Windows' from Freedom Scientific, 'Window-Eyes' screen-reading program with portable application, 'Zoom Text' magnifier/reader and 'zoom Text' keyboard, 'Dragon Naturally Speaking' which is a speech-to-text engine that allows users to dictate into Windowscompatible programs, such as Microsoft Word and Outlook and 'Text Aloud' which is a Textto-Speech (TTS) software, Scanner/Reader, Talking Calculator, Voice Recorder/CD player, Braille Printer/Embosser, Speech Synthesizer, Magnifying Glasses, Tactile Image Enhancer and Single Handed Keyboard. These devices are all important in the lives of persons with disability especially the blind but most of them are expensive and difficult to come by especially in Africa. In India also, there is this lack according to the study. Using a survey method, one can expect a larger population but using just 15 libraries may not allow for generalization of findings. Yet still it can be said that AT now comes in different form and sophistication. Manduchi (2012) examined one of such.

He considered a specific mobile vision task: the detection of "landmarks" in the environment, along with mechanisms to guide a person towards a detected landmark without sight. Specifically, he considered both the discovery and guidance components of vision task. For example, in the case of a blind person visiting an office building, looking to find the office of Dr. A.B, he or she may walk through the corridor (while using a white cane or a dog guide for mobility), using the camera phone to explore the walls in search of a tag with the desired information. Suppose that each office door has a tag with the room number and the occupant's name. The vision algorithm implemented in the camera phone can be programmed to identify tags and read the text in each tag.

He considered three environments that were representative of a variety of realistic indoor situations. Eight (8) blind volunteers (two men and six women, aged 50 to 83)

participated in the experiment. Only one of them was congenitally blind; the others lost their sight at various stages in life. The correct usage of the system was explained to participants and were given ample time to experiment with a test marker at a known location within each environment. Each test comprised eight trials. In each trial, the participant was led by hand to the starting location for the current environment and asked to search, using the cell phone, the camera pointing forward, for one specific marker (whose location was unknown to the participant). The investigator used a stopwatch to record the time at which the phone first beeped after detecting a marker, and the time at which the participant touched the marker (which concluded the trial). The total experiment (including initial training) took between three and four hours per participant.

Finally, almost all participants commented positively on the chosen interface, but noted that it may be impractical to use it if other people were nearby (who could be annoyed by the beeping). Most participants appreciated the information provided by the interface: approximate distance to the target (through the beeping rate) and bearing angle (through beeping loudness). However, at least two participants seemed to confuse the role of two features (beeping rate and volume). This confirms his previous observations that rich interfaces may easily become too complex, especially when one is already concentrated in other mobility tasks. This experiment has resulted in a number of interesting (and at times unexpected) observations, which may inform the design of future way-finding systems mediated by computer vision (Manduchi, 2012). Such gadget may work efficiently at places where few members are, but for a place like a university where aside the large number of people area, offices and faculties keep changing, it will be difficult to use such devices. The duration of this experiment per participant might have adversely affected the achievement of the participant. Since there is such a high level of control in experiment and only one specific variable is being tested at a time, the results are much more relevant than some other forms of research methods. The success and failure of the work can clearly be seen.

A similar work was also done to determine people's frustration specifically to the web. In this study, 100 blind users, using time diaries, recorded their frustrations using the Web. The top causes of frustration reported were (a) page layout causing confusing screen reader feedback; (b) conflict between screen reader and application; (c) poorly designed/unlabelled forms; (d) no alt text for pictures; and (e) 3-way tie between misleading links, inaccessible PDF, and a screen reader crash. Most of the causes of frustration, such as inappropriate form and graphic labels and confusing page layout, are relatively simple to solve if Webmasters and Web designers focus on this effort. In addition, the more technically challenging frustrations, such as screen reader crashes and conflicts, need to be addressed by the screen reader developers. Blind users in this study were likely to repeatedly attempt to solve a frustration, not give up, and not reboot the computer. In this study, the blind users reported losing, on average, 30.4% of time due to these frustrating situations (Lazar, Allen, Kleinman, & Malarkey, 2007).

The method of collecting data was ideal but this may consume a lot of time and effort since a participant had to record daily for a particular period their views in a dairy. Nevertheless, it helped in giving a detailed and precise result regarding their frustration with the web when using assistive software. A phone survey was also conducted with 80 visually impaired people in Turkey to understand what types of assistive products are used and to what extent. The perceived utility of selected products and reasons for nonusers were investigated. Descriptions of products that would be useful for the participants but may not be available on the market were also obtained. The three most used assistive products were found to be computer screen readers (46%), talking watches (26%), and screen readers for cellular phones (21%). Cellular phones with screen reading capability are the most desired assistive products among the

visually impaired community, but their high cost is a major barrier. Most of the relevant technologies are available but some product development, such as adaptation to the Turkish language, is necessary. The three products most frequently requested are bus station/destination announcement systems, devices that warn the person about barriers, and devices that read printed documents and signs (Bengisu, 2010).

Though this particular study brought to the attention that computer screen readers like JAWS and NVDA are mostly used by visually impaired persons in Turkey, using a phone survey might have subjected the work to a lot of flaws. These may include: less control, lack of visual materials, limited potential respondents, inability to access telephone numbers, problems with answering machines, limited complexity of questions and limited open-ended questions. Though it has the advantages of Rapid data collection, Lower cost, Anonymity and Large-scale accessibility, its disadvantages outweigh its advantages. Turkey has a population of 74.93 million as at 2013 so 80 participants were an unfair representation of the population therefore findings of this study cannot be generalized. Among the three products mostly requested included devices that read printed documented and signs. Ndungu (2011) investigated what informs students with visual impairment in what literacy medium to use in reading print and writing.

The purpose of his study was to investigate the literacy medium used by secondary school learners with low vision in Kenya. The study further aims at investigating the factors that influence the Leaner's choice of literacy medium. In his study a survey design was used with questionnaire as data collection tool. A stratified random sample consisting of ninetythree (93) male and female learners with low vision drawn from a special residential school for the learners with visual impairments participated in the study. Data was analysed using descriptive statistics; frequencies and percentages. Findings of the study indicate that majority of learners with low vision use Braille as their primary medium of reading and writing, although a relatively significant percentage also use print with and without aid of low vision devices. The learner's choice of the literacy medium was influenced by mechanical and social factors. Mechanical factors included quantity and quality of assignments, ability to take notes in a chosen medium, reading rate, comprehension and accuracy, fatigue, physical dexterity and working distance from the page. Social factors included portability, availability and the family's or teacher's perception of the learner's needs. Based on the findings, the study recommended the need to develop tools and procedures of examining the literacy medium for learners with visual impairments as well as formalize learning medium assessment in education programming for learners with visual impairments (Ndungu, 2011).

As part of the very few studies done on assistive technology for the visually impaired, Ndungu brought to light the influence of the choice of assistive device that is chose as a medium of reading and writing. Though a sample size of 93 may not have been a fair representation, the study brought to bear the extensive use of braille as a medium of literacy for secondary school students for the blind in Kenya. A questionnaire as the data collection tool may not have given an in-depth information to the reasons for the students choosing a particular device as a medium of literacy but an interview as the data collection tool will give more understanding and insight to this study if used. Again, from this study only few devices were mentioned like Braille, magnifiers, audio tapes and computers with voice synthesis. One may think that in the advancement of assistive technology, Africa precisely Kenya is far behind. Another study done in the United State of America showed otherwise.

The study provided an overview of the various products available for library patrons with blindness or visual impairments in USA. A sample of American universities that are recognized for their programs for students with visual impairments was surveyed to discern

which assistive technology products are available in their libraries to provide some insight into the status of library services for patrons with blindness. The first library, Library A, reported that it only possessed one of the items on their list, the Kurzweil 1000. Library B reported that they did not have any of the software on the list, although what they did have was JAWS. Library C had only one of the programs from the list although the respondent noted that they had JAWS and Zoom text software.

The library relies heavily on the state to supply them with Braille materials and talking books. The respondent from Library D reported that the campus did not even have an assistive technology person and went on to explain that the library and the university in general were over five years behind. Library E reported that it possessed the Kurzweil 1000 in addition to a software that was not on the list, but did not provide any indication of what that software might be. Library F provided the most comprehensive overview of its services. In terms of software and equipment, they have Kurzweil Reading Edge, a machine that scans text and converts it to audio (a piece of equipment that the authors had not run across in their initial research); JAWS; magic, an image enhancer; closed circuit magnification readers and a Braille writer. They also have the thirty-six-volume Webster's Student Dictionary, Braille Edition. Overall, it was concluded that it does not seem that the issue of providing adequate and appropriate technologies and services for individuals with disabilities is receiving the attention that it should in most libraries. In many cases the lack of assistive technology and training is a result of a lack of funding. In other cases, negligence in the area of disability services is the result of ineffective management. There is only so much money available, and it is often difficult to convince administrators that money should be allocated for disability services. The problem is self-perpetuating: Students with visual impairments are hesitant to attend a college where adequate services are not provided because there are not enough students with visual impairments to justify the requisition of new equipment (Sunrich, 2006).

Though some libraries used in this study seem to have a lot of devices, majority of the libraries were still lacking. This proved that assistive technology for the visually impairment is not receiving the attention it needs. So many devices are been developed but its availability and affordability are the issue of concern. In Africa especially Ghana, less is been said in the availability of these assistive devices and not much research has gone to it. Among the few research done in this area in Ghana was a qualitative study conducted by Gadagbui and Ocloo (2003) as a second attempt to investigate the attitude leading to the acceptance of Braille as a mode of instruction. The study used 80 pupils with varying degrees of visual impairment (low vision). The instruments used were questionnaires, interview schedules, observation and work sample analysis. Results indicated that most of the children in the sample had the potential to read bold print. Efforts were made to advise and put in place strategies to improve reading abilities of borderline cases of children who read Braille slowly. Implications of the main findings such as the negative effects on teaching and learning have been identified to inform the Ministry of Education.

There are two main basic schools for the Blind in Ghana namely, the Akropong School for the Blind which is situated in the Eastern Region of Ghana and the Wa school for the Blind which is located in the Upper West Region of the country. The total enrolment of the two schools is 496 pupils. Among these pupils are 292 with varying degrees of low vision which can be found at all levels ranging from the pre – school to the Junior Secondary School (Ministry of Health, 2003) making their sampling size of 80 not a good representation of all the students with low vision. A qualitative method that was used gave a more vivid explanation to the study. The study just investigated one assistive device that is the Brialle leaving all other

modes of instruction for the visually impaired and also concentration was on only individuals with low vision neglecting the totally blind.

According to the Royal National Institute for the Blind (RNIB, 2014) some of the most important assistive technology for the visually impaired includes: Screen readers that converts electronic text to speech; Screen magnifiers that presents enlarged screen content; Speech recognition software that allows input of data using voice rather than a mouse or a keyboard, Text-to-speech (TTS) software that converts written text into audio files that can be played on a wide range of devices; optical character recognition (OCR) software which scanned text and converts the scanned image into an electronic text file; Large monitors that make on-screen reading easier by providing more space on-screen and are helpful for persons with low vision; Closed circuit television (CCTV) which are devices that use cameras to magnify large format printed materials and objects; Magnifiers which are smaller optical devices and are placed on objects to magnify smaller items or text and are available with or without light sources; Dictation devices and transcription which allow people to record meetings or take notes that can be transcribed from the recording made; Scanners- Scanners that convert images from printed material to a computer file.

Assistive technology allows individuals with visual impairment to overcome a major part of the difficulties in their daily lives and offers them independence and autonomy in their education and access to communication, just like their peers with vision (Alves, Monteiro, Rabello, Gasparetto, & Carvalho, 2009). Several studies have shown that assistive technology has advanced and has positively influenced the lives of persons with disability especially in the area of education (Achieng, Makori Omoke, & Aluko Orodho, 2015; Brokop & Mcintosh, 2009; Hooker, 2007; Lazar, Allen, Kleinman, & Malarkey, 2007).

One study done by Alves, Monteiro, Rabello, , Gasparetto and Carvalho (2009) to verify the application of assistive technology, especially information technology in the education of blind and low-vision students from the perceptions of their teachers found that there are differences in the specificities and applicability of assistive technology for blind and low-vision students, for whom specific computer programmes were important. Information technology relating to assistive devices enhances reading and writing skills, as well as communication with the world on an equal basis, thereby improving quality of life and facilitating the learning process. They concluded that Assistive technology is applied to education of students with visual impairment; however, teachers indicated the need for infrastructure and pedagogical support and that, Information technology is an important tool in the inclusion process and can promote independence and autonomy of students with visual impairment. From observation, most students with visual impairment in the University of Cape Coast make use of one or more assistive device(s) and there is the need to measure the influence these devices have on their academic achievement. This research therefore examines the role assistive technology plays in the academic achievement of students with visual impairment in the University of Cape Coast.

Research Question

To guide the conduct of this study, a research question was used. The research question was: What types of assistive technology devices are available to the students with visual impairment in the University of Cape Coast?

Research Methods

This study adopted an interpretive phenomenological methodology using a case study design. It is an approach that tries to comprehend the meanings and essence of an experience and how participants make sense of these (Grbich, 2007). The intention and adoption of this approach was to gain insight into the views of respondents on the usage of the assistive device in UCC. The approach was also viewed as being suitable for the purpose of this study because the case study approach invites an intensive examination of the phenomena under investigation. Because they are so intensive and generate rich subjective data, they bring to light variables, processes and relationships (Burns, 2000). In fact, Merriam (1998) identifies 'process' as a focus for case study research.

The case study enabled the researcher to ask participants direct questions. In effect, the inner dynamics of the phenomena were illuminated through an examination of participant perspectives. In this research, the phenomenon under examination was the assistive device utilisation in UCC. The case study approach was seen as a way to intensely explore this bounded system and to draw attention to the relationship between this bounded system and a broader social world. Hitchcock and Hughes (1995) identify a series of hallmarks that underpins case-based approaches. These assumptions were relevant to the purposes of the study.

The researcher's methodological positioning in this approach was informed by the nature of the research questions and the data that needed to be answered or illuminated. In applying the epoch practice, the researcher explained the phenomenon with a view to understanding it from the perspectives of participants and not from the point of the researcher. This helped the researcher to fully understand the phenomenon in a tolerable sense. This relevance explains the researcher's leaning towards the interpretive qualitative methodology.

Research population is the entire set of individuals of interest to a researcher (Gravetter & Forzano, 2009). The population of this study was the 30 students with visual impairment in the University of Cape Coast. This comprised of 8 females and 22 males. Most of these students were within the age range of 21 to 35 years of age and are pursuing a bachelor's degree. There are a few of them who are above the age range and are pursuing a master's degree or PHD. Among the varied disability conditions, the number of individuals with visual impairment studying in the University of Cape Coast far outnumber that of the other categories. Therefore, the visually impaired form a visible group which could be studied in an attempt to examine the role of assistive technology in academic achievement of individuals with disability in the University of Cape Coast.

Sampling is the process of selecting smaller portions of the larger population to be studied in order to draw conclusions from the sample to the population from which the sample was drawn (Orodho, 2012). The study employed a census technique where all the research population forms part of the study. This is also not a sampling technique but it deals with the investigation of the entire population. Here the data is collected for each and every unit of the population. This method provided more accurate and exact information as no person was left out (Pandey & Pandey, 2015).

The main research instrument used was a semi-structured interview. Interview is an important data gathering technique involving verbal communication between the researcher and the subject. There are a range of approaches to interviewing, from completely unstructured in which the subject is allowed to talk freely about whatever they wish, to highly structured in which the subject responses are limited to answering direct questions. Semi-structured interviews involve a series of open-ended questions based on the topic areas the researcher wants to cover (Skinner, Edwards, Corbett, 2014). They are non-standardized and are

frequently used in qualitative analysis. The researcher did not do the research to test a specific hypothesis (David, & Sutton, 2004). The researcher had a list of key themes, issues, and questions to be covered. In this type of interview the order of the questions can be changed depending on the direction of the interview. An interview guide is also used but additional questions can be asked. Corbetta (2003) explains semi-structured interviews as the order in which the various topics are dealt with and the wording of the questions are left to the interviewer's discretion. Within each topic, the interviewer is free to conduct the conversation as he thinks fit, to ask the questions he deems appropriate in the words he considers best, to give explanation and ask for clarification if the answer is not clear, to prompt the respondent to elucidate further if necessary, and to establish his own style of conversation. Additional questions can be asked and some may be questions that have not been anticipated in the beginning of the interview.

This type of interview gives the researcher opportunities to probe for views and opinions of the interviewee. Probing is a way for the interview to explore new paths which were not initially considered (Gray, 2004). Having key themes and sub-questions in advance helps in giving the researcher a sense of order from which to draw questions from unplanned encounters (David, & Sutton, 2004). When using semi-structured interviews, the researcher is freer than conducting a structured interview (Kajornboon, 2004). This means the interviewer does not have to adhere to a detailed interview guide. Patton (2002) recommends to explore, probe, and ask questions that will elucidate and illuminate that particular subject to build a conversation within a particular subject area, to word questions spontaneously, and to establish a conversational style but with the focus on a particular subject that has been predetermined.

The strengths of semi-structured interviews are that the researcher can prompt and probe deeper into the given situation (Kajornboon, 2004). Hence, with this type of interview the interviewers are able to probe or asked more detailed questions of respondents' situations and not adhere only to the interview guide. In addition, the researcher can explain or rephrase the questions if respondents are unclear about the questions. The drawbacks are inexperienced interviewers may not be able to ask prompt questions (Koskei, 2015). If this is the case, some relevant data may not be gathered. In addition, inexperienced interviewers may not probe into a situation (Kajornboon, 2004). Therefore it is prudent that a researcher must be trained very well before using this method.

The open-ended nature of the question defines the topic under investigation but provides opportunities for both interviewer or researcher and interviewee to discuss some topics in more detail (Cohen & Crabtree, 2006). If the interviewee has difficulty answering a question or provides only a brief response, the interviewer or researcher can use cues or prompts to encourage the interviewee to consider the question further. In a semi-structured interview, the interviewer or researcher also has the freedom to probe the interviewee to elaborate on the original response or to follow a line of inquiry introduced by the interviewee (Cohen & Crabtree, 2006). The use of interview here was to conduct an in-depth study into the role of assistive technology in the academic achievement of the students with visual impairment and to obtain accurate and reliable information from the study participants.

The researcher predetermined some open-ended questions covering the various aspects of the study. The semi-structured interview guide has four main sections. The first section covers demographic data so questions relating to the participant's age, sex, type of visual impairment, current level in the university, programme of study and duration of the programme were asked. The second section was about the types of assistive devices available to the participants. Under this section, the interviewees' reason for studying in UCC was elicited as well as their special educational needs. Furthermore, emphasis was also placed on what

interviewees' expectations of assistive devices in UCC were and what they actually came to meet and use. Interviewees also shared their views on outmoded and modern assistive devices.

The third section covered the role assistive technology play in the education of the students with visual impairment and low-vision. The students were required to supply their grades in order to find their academic standing. After that, specific evaluation was made on various learning areas like reading skills, writing skills, mathematics and mobility.

The final section found out how students with visual impairment can be assisted to achieve their best through the use of assistive technology in the University of Cape Coast. This was also done in relation to various skilled areas like reading, writing, mathematics and mobility. The appropriate clearance and permission were sought for from various authorities before data was collected.

The interview was conducted by the researcher. Responses from the respondents were tape recorded so that the researcher did not miss important details from the respondents and then later transcribed using the computer. Few problems were encountered during the data collection period. One major problem was some participants were not willing to participate because of their busy schedule and their unwillingness to disclosure their CGPA. Therefore, at the end 20 out of the 30 participants took part in the data collection, thus representing 67% of the population.

Another problem was some participants' total deviation from the question. Though this was a structured interview and participants were guided at certain points some still went out of context and spoke about what they felt like talking about. There were few incidents of interruption especially from phones but almost all the interviews were done in a calm and conducive atmosphere. Most of the interviews were held at the Resource Centre for Alternative Media and Assistive Technology (R-CAMAT) in UCC. This is where most of the academic activities of the students with visual impairment are conducted. Only three participants had theirs in their halls of residence. Finally, the researcher reported the responses as given by the respondents verbatim.

Ensuring Reliability and Validity in Qualitative Research

Traditionally, "validity" and "reliability" have been viewed as concepts through which research methods, data analysis and study findings can be "verified" or "reproduced" and deemed "accurate" (Gratton & Jones, 2004). Reliability and validity are conceptualized as trustworthiness, rigor and quality in qualitative paradigm. This can be achieved by eliminating bias and increasing the researcher's truthfulness of a proposition about some social phenomenon by ensuring credibility, trustworthiness, transferability, dependability and conformability of a research study (Krefting, 1991). Reliability and validity were obtained by using a combination of strategies of the following recommended by McMillan & Schumacher (2006).

1. Credibility - The credibility construct relates to the extent of correspondence between participants actual view points and how these have been portrayed by the researcher. In other words, it refers to the credibility of portrayals of constructed realities (Kincheloe & McLaren, 1998).
2. In ensuring this, I employed a prolonged and persistent field work. I also ensured that the interviews and discussions were carried out thoroughly so as to obtain a deep and complex understanding of the phenomenon under study, and those participants were given support and respect throughout the process of th**e** study (Morrow, 2005).
3. Reflexivity: Reflexivity is rigorous self-scrutiny by the researcher throughout the research process and is an important procedure for establishing credibility. To achieve

reflexivity, I kept a journal throughout the whole research study to track my own ideas, responses and 'biases' (Cohen, Manion, & Morrison, 2000). This was done to ensure that my responses were kept separate from the responses of the participants.

4. Member checking: This ensured that data was taken back to the participants to correct factual errors, to offer respondents the opportunity to add further information or to put information on record, to provide analysis and to check the adequacy of the analysis (Cohen, et al., 2000). I also asked participants to review researcher's synthesis of interviews and discussions with participants for accuracy of representation frequently done in interview studies.
5. Peer debriefing: This includes the sharing of information of the research study (Cohen, et al., 2000). But given the confidentiality of the research participants, I was not able to discuss the data. I was able to discuss the analysis process with my colleagues to obtain their constructive feedback on ways to ensure that I was true to the data by ensuring that it was analysed thoroughly.
6. Dependability - Dependability relies on the establishment of an "audit trail" (Morrow, 2005). Sandelowski (1986) explains that the development and maintenance of a clear analysis trail aids the confirmability of research findings. Dependability in a qualitative research study compels researchers to provide a dense description of research methods, Peer examination processes take place and the adoption of triangulation to further verify the data (Krefting, 1991). Dependability was adhered to by carrying out member checks and providing a rich description of the research methods. I also ensured that the data was analysed and coded accurately. This was done by continuously coding and re-coding in order to highlight patterns that emerged from the research. I also made sure that I prevented the premature closure of the data by continuing to collect data and analyse until theoretical saturation was reached.

As Miles and Huberman (1994) identify three major approaches to qualitative data analysis which include: interpretive approaches, social anthropological approaches and collaborative social research approaches, this research adopted the interpretive approach, whereby interviews were transcribed into written text for analysis. The authors of the approach note that the theoretical approach adopted for the study largely determines how the text is interpreted. All the interview sessions were taped and information from the audio recorder was reviewed several times to obtain verbatim accounts of the interviews. All redundant or overlapping statements were removed, leaving only those points that were pertinent to the study. These points were later summarised and presented as data for the research.

Thematic analysis was used for the analysis of the data as it dealt with naturally occurring events and it provided vivid descriptions and information that led to answers (Miles & Huberman, 1994). Thematic analysis helped produce categories from the data, unlike quantitative strategies which predetermine categories. Thematic analysis is performed through the process of coding in six phases to create established, meaningful patterns (Braun & Clarke, 2006). These phases are:

1. familiarisation with the data
2. generating initial codes
3. searching for themes among codes
4. reviewing themes,
5. defining and naming themes
6. producing the final report

Phase 1: Becoming Familiar with the Data

Transcription was the first thing I did in analysing the data. The process of transcription, though it was time-consuming and at times boring, it was an excellent way of starting to

familiarise myself with the data. Some researchers even argue that it should be seen as key phase of data analysis within interpretative qualitative methodology (Bird, 2005) and recognised as an interpretative act, where meanings are created, rather than simply a mechanical one of putting spoken sounds on paper (Lapadat & Lindsay, 1999). A sample of transcribed data can be seen in Appendix A.

In other to familiarise myself with the data, I collected the data myself. I repeatedly read the transcribed data and even listened to the audio data again to fill any gap in the transcribed work (Braun & Clarke, 2006). Each interviewee was given a code for easy referencing (Sommers and Sommers, 2002). For instance, the first interviewee was given participant 1. Since the data was collected through an interactive means, I came to the analysis with some prior knowledge of the data. During this phase, I started taking notes and marking ideas for coding.

Phase 2: Generating Initial Codes

In the second phase, I generated an initial list of items from the data set that have a reoccurring pattern. The systematic way of organising and gaining meaningful parts of data as it relates to the research question is called coding (Braun & Clarke, 2006). The coding process evolved through an inductive analysis and was not considered to be a linear process, but a cyclical process in which codes emerge throughout the research process. This cyclical process involved going back and forth between phases of the data analysis as needed until satisfied themes were derived (Braun & Clarke, 2006). I went beyond surface meanings of the data to make sense of the data and tell an accurate story of what the data meant (Braun & Clarke, 2006).

The coding process was rarely completed the first time. Each time, I refined codes by adding, subtracting, combining or splitting potential codes (Saldana, 2009). Coding, according to Taylor and Gibbs (2010), is the process of examining the data for themes, ideas and categories and marking similar passages of text with a code label so that it can easily be retrieved at a later stage for further comparison and analysis. Start codes were produced through terminology used by participants during the interview and was used as a reference point of their experiences during the interview. The codes facilitated my ability to locate pieces of data later in the process. Initial coding sets the stage for detailed analysis later by allowing me to reorganise the data according to the ideas that have been obtained throughout the process. Throughout the coding process, full and equal attention was also paid to each data item which helped in the identification of unnoticed repeated patterns.

In this stage, reduction of codes was initiated by assigning labels to the data set based on the research question(s). Condensing large data sets into smaller units permits further analysis of the data by creating useful categories (Coffeey, 1996). Coding aids in development, transformation and re-conceptualization of the data and helps to find more possibilities for analysis (Coffeey, 1996). Based on the reoccurrence of certain elements in the data multiple initial codes were derived. For instance the following responses by participants were coded as follows:

> *I decided to study in UCC because I find it wise that the thing that I need in my education is somehow provided in the school. The skills or the job I want to do in future is also being taught or the skill that I require is also been taught in UCC so I decided to come* ***(Job Security).*** Student 1
>
> *There is a machine unfortunately I have forgotten the name, it looks like a scanner* ***(Scanner That Reads)*** *when you put your print hard copy book on the scanner it will read automatically without getting the soft copy or getting someone to read it*

out so it can make learning and reading very easy and there is another machine, a recorder when you record it can convert the audio to a readable text. These devices I am aware of their existence but are not in UCC. Student 5

So in Student 1's response to a question about his or her decision to study in UCC, 'job security' was identified as a code in the response. With the second example, 'scanner that reads' was marked as a code for his/her response.

Phase 3: Searching For Themes

According to Braun and Clarke (2006), a theme is a coherent and meaningful pattern in the data relevant to the research question. If codes are the bricks and tiles in a brick and tile house, then themes are the walls and roof panels. Themes differ from codes in that themes are phrases or sentences that identify what the data means. They describe an outcome of coding for analytic reflection. Themes consist of ideas and descriptions within a culture that can be used to explain causal events, statements, and morals derived from the participants' stories.

In this phase, I developed a list of themes and begun to focus on broader patterns in the data, combining coded data with proposed themes (Braun & Clarke, 2006). This phase refocused the analysis at a broader level of themes and involved sorting the different codes into potential themes, and collating all the relevant coded data extracts within the identified themes. From the data 3 major themes were developed and sub themes were also developed under them. The three main themes were in line with the three research questions for the study. Thus, one theme was about the types of Assistive Technology that is available, the role AT plays in academic achievement with the SVI and finally the support AT can give to SVI in their academic achievement. *Phase 4: Reviewing Themes*

This phase allowed for further expansion on and revision of themes. Some existing subthemes collapsed into each other while other themes were summarized into smaller units (Braun & Clarke, 2006). Connections between overlapping themes served as important sources of information and alerted the researcher to the possibility of new patterns and issues in the data. Deviations from coded material notified the researcher that a code may not actually exist. For instance student 20 gave a response and was coded as follows:

*'Mmmmmh i think the one that I can talk about is human assistive device (**Human Assistive Device**). I have read in some literature that aaaaaaah in some institutions outside Ghana where students are given some resource persons if I should put it this way aaah who help them to write their exams to do their assignment in this form like the resource persons are there assigned to some particular student and when they have assignment they don't braille it those resource persons act as secretaries to them so they have a name for it.'*

Through the review of the major themes and sub themes, a code like human assistive device prompted me that that code may not actually exist. Since the main themes were predefined, only some few sub themes had to be reviewed. Pattons (1990) dual criteria for judging categories - internal homogeneity and external heterogeneity – were also used to refine the sub themes. Data was clear and identifiably distinct between themes. All the collated extracts for each theme was read and appeared to form a coherent pattern.

Phase 5: Defining and naming themes

In order to identify whether current themes contain sub-themes and to discover further depth of themes, it was important to consider themes within the whole contest of the study and also as autonomous themes (Braun & Clarke, 2006). Finally, 3 major themes and 15 sub themes were defined and refined by identifying the essence of what each theme is about and determining what aspect of the data each theme captures. I went back to the collated data

extracts for each theme and organised them into a coherent and internally consistent account, with accompanying narrative.

Phase 6: Producing the Report

After final themes have been reviewed, I began the process of writing the final report. While writing the final report, I decided on themes that make meaningful contributions to answering the 3 research questions. A final analysis was written to convey the dense story of the data in a manner that assures readers of the validity and merit of the analysis. A clear, concise, and straightforward logical account of the story across and with themes is important for readers to understand the final report (Braun & Clarke, 2006). The final step in producing the report included member check as a means to establish credibility. I took final themes and supporting dialog to some participants to elicit feedback (Braun & Clarke, 2006). Braille copies of final themes and transcribed dialog were made for participants to verify. For easy identification and reference participants interviews were given special labels. For instance, the first participant was referred as Student 1. As far as possible, I made the effort to attend to all evidence, address the research questions as well as all major rival interpretations devoid from my preconceptions as embedded in the interpretive phenomenology. This helped me to distance myself from the data thereby interpreting and discussing the issues as they were.

Results and Discussions Assistive technology available

Preferably, every inclusive educational institution that admits persons with visual impairment into its system is expected to make provision for human and material resources that cater for the needs of such persons. With this said, it is expectant that students with visual impairment express their views on the available assistive technology known to their senses. In the interviews conducted, majority of the participants expressed that UCC has assistive technology for persons with visual impairment. The views of three of the participants succinctly validate this:

> *We have computers. Our resource centre has both wifi and broadband network to assist us. We also have the personnel in terms of the resource persons and those who assist the resource persons to make sure that the materials are kept in a format that we can access. We have the braille machines and the frames that some of us do not need to carry frames and machines to come before we get our quizzes written. We also have the embosser that is used in turning print format into braille format for us. (Student 16)*
>
> *We have computers in the university, we are also given recorders and Perkins brailler and we have embosser to emboss our work. In addition to those I mentioned, the Perkins and embosser, the Centre has some computers for students which has jaws installed on them and students are given recorders to facilitate in their studies. Yea so these things are available. (Student 3) Some of the equipment were available but were not sufficient to cater for us. They include the embosser, scanner and the desktop computers. We have the frame, stylus, the Perkins and the closed circuit televisions. (Student 14) When I came in yes I have a digital recorder which helps me to record my lectures. (Student 11)*

The assertions from the participants clearly shows that the assistive technology available to students with visual impairment are Perkins Braille, Braille embossers, scanner, closed circuit- television (CCTV), digital recorders and computers installed with screen reader (JAWS- Job Access With Speech).

Preferred assistive technology used by students with visual impairment in the University.

Even though participants expressed their viewpoints on the assistive technology available to them, participants were required also to talk about the assistive technology most preferred or used. On this premise, the participants were asked: "Which of the assistive technology do you prefer or use often and why?" The responses to this question were unanimous. The majority of the participants were of the view that the most utilised assistive technology by them was the computer, braille, CCTV and tape recorder. According to the participants the computer, braille, CCTV and tape recorder play pivotal role in their education and for that reason they utilized its services in their daily learning. The views of the participants threw much light on this:

> *I really prefer using the computer with the screen reader software because it aids me in the typing of my assignments, it aids me in my research work when I want to do my assignment or look for some information for my personal reasons. It also aids me to read the books that are in soft copy very easily and at least it makes learning really easy. (Student 11)*
>
> *I use the recorders and braille sheets because for the recorders that's what I use when I go for lectures. If I don't have it I don't feel comfortable and for the braille sheets that's what I use for almost everything like quizzes, assignments, and exams. (Student 18)*
>
> *I prefer the recorder for lectures to pick information at lecture rooms every bit of detail that is why I like the digital recorder to listen to and make my own notes out of it. And also, the computer screen reader that is the JAWS enables me to have access to the computer and then the internet and get everything through audio which helps me to do my presentation and assignment (Student 20). I use the CCTV because its enlargers my printed works. (Student 1)*

The statements from the participants gave the indication that the computers in the resource centre are used by students with visual impairment purposefully to engage in research works and also to do assignments. Added to this, participants claimed that with the help of the JAWS software installed on the computers, they were able to read the books that are in soft copy. This means that, given that the available computers were not installed with the JAWS software, academic exercises would have been daunting for students with visual impairment. Participants' use of the tape recorders and braille sheets were on the grounds that they used them to take notes during lectures and write their quizzes and assignments respectively. There was also a participant who did not have preference for any of the assistive devices available but in all CCTV, Computer, Braille equipment and Digital Recorders were the preferred devices used by the students.

Assistive technology perceived by students with visual impairment as outmoded

With the advent of new inventions in this twenty-first century, a lot of technologies are becoming obsolete and no longer considered relevant in the world of work of which when it comes to technology used by students with visual impairment is no exception. Excerpts from the interviews revealed that students with visual impairment have insights on assistive technology that they consider as outmoded. From the interviews, few of the participants expressed that none of the devices were outmoded. However, the majority were vehement on two devices they considered as outmoded assistive technology. These are the Perkins braille and the hand frame. According to these participants, the usage of these devices does not only

retard their exposure to modern technology but also takes a lot of energy and time from them. The participants vociferously claimed that:

> *…the frame is outmoded, you see that there are other forms of technology like the Perkins brailler that you will be able to read when you are writing simultaneously but you see that the frame because of how it was made once you fix the paper and you are writing unless you turn it. You may make a mistake that requires that you read what you have written but that is not possible. (Student 16)*
>
> *…the Perkins brailler is outmoded. I think it came a long time ago and as at now the Perkins brailler although they are there most of them are not in good shape and mostly you can't find them anywhere too. (Student 17)*
>
> *The hand frame is outmoded. It takes a lot of energy. It consumes a lot of energy, sometimes when you have to write a lot of papers you become very tired. I think that it is outmoded. (Student 18)*

The reasons given by participants for the braille and hand frame devices being outmoded were on the assumption that they took a lot of energy and time, and they did not give room to effect mistakes committed during writing.

Assistive technology perceived by visually impaired students in UCC as modern but not available

In the interviews conducted, participants expressed their thoughts about modern assistive technology they perceived were lacking. According to the participants the new inventions included Projector, Electronic braille, Computer with Braille display, Audio reader, Scanner that reads, Apex brailler, Daisy and the translator stroll, Talking calculators, Embosser that print within 60 minutes, the apex braille and smart cane. To these participants, the university does not have such technologies. The participants expressed varied opinions but the commonest ones mentioned were apex braille, talking calculator and smart cane:

> *I have heard of one device which is almost like a laptop computer but has the additional features of braille in it so as you get the print you get the braille alongside it (apex braille) but unfortunately it is not available here which I think if gotten will further aid our success. (Student 11)*
>
> *I have heard of a talking calculator…those things are very good, talk of calculating mathematical. In our movement too I heard of this white cane they brought which when you hold it for example when you are heading towards something it vibrates to alert you but I think that is lacking. I think that would have been better than this one we are using. (Student 15)*
>
> *There is another one that is called… I have forgotten. I think it is a talking braille something. Braille computers it has 6 keys, you type and you can print it out. After typing your braille you can convert to print and it will change it but we don't have them in UCC. (Student 6)*

The remarks from the participants clearly showed that UCC is lacking in modern day assistive device for students with visual impairment in the area of the apex braille, talking calculator and smart cane. The lack of these technologies does not only make learning difficult for students with visual impairment but also leads to the situation where students graduate from the University and cannot cope with the ever-changing development in their area. Assistive technology for persons with visual impairment are equipment and tools that help them to participate in education, enables them to access information and to complete tasks efficiently. The findings of the device availability was in line with the opinions of the Royal National Institute for the Blind (RNIB,2014) who contend that there is a wide range of assistive

technologies for people with visual impairment that provides plenty of choice for users at all stages of sight loss. There are several categorizations made by leading institutions as per the nature of the task to be performed, kind of technologies or, place of use.

According to the RNIB (2014) some of the most important assistive technology for the visually impaired includes: Screen readers that converts electronic text to speech; Screen magnifiers that presents enlarged screen content; Speech recognition software that allows input of data using voice rather than a mouse or a keyboard, Text-to-speech (TTS) software that converts written text into audio files that can be played on a wide range of devices; optical character recognition (OCR) software which scanned text and converts the scanned image into an electronic text file; Large monitors that make on-screen reading easier by providing more space on-screen and are helpful for persons with low vision; Closed circuit television (CCTV) which are devices that use cameras to magnify large format printed materials and objects; Magnifiers which are smaller optical devices and are placed on objects to magnify smaller items or text and are available with or without light sources; Dictation devices and transcription which allow people to record meetings or take notes that can be transcribed from the recording made; Scanners- Scanners that convert images from printed material to a computer file. Standalone reading machine which is an integrated machine with a scanner, OCR, and speech software, which functions without the need for a computer; Refreshable Braille displays which is an output device that displays Braille reading interface by connecting to computers from what is on-screen; Braille embossers which are specialized printers that produce Braille embossed documents; Braille writers- Braille writers that can be either manual or electronic devices that are used for Braille input; Manual Braille writers produce Braille onto paper and electronic Braille writers input Braille directly into a computer and Digital books- Digital books are available via handheld devices or tablets and use a variety of formats, many of which are specific to the device being used.

From the foregoing list given by the Royal National Institute for the Blind (RNIB, 2014), it is evident that students with VI in UCC have not been adequately exposed to varieties of assistive technologies available in the market. This may not be a totally heart-breaking finding since other literatures had also established that there are different types of assistive technology in various institutions. For instance, a research conducted in Ontario by Sider and Maich (2014) on Assistive technology tools noted that a wide range of assistive technology including interactive white boards, text- to- speech software and classroom amplification system were being used by teachers to benefit both students engagement in the classroom and their independence in completing class activities and assignments.

Some other literatures (Sanaman, & Kumar, 2014; Manduchi, 2012; Bengisu, 2010; Ndungu, 2011 and Sunrich, 2006) also mentioned various devices which included JAWS for Windows' from Freedom Scientific, 'Window-Eyes' screen-reading program with portable application, 'Zoom Text' magnifier/reader and 'zoom Text' keyboard, 'Dragon Naturally Speaking' which is a speech-to-text engine that allows users to dictate into Windowscompatible programs, 'Text Aloud' which is a Text-to-Speech (TTS) software, Scanner/Reader, Talking Calculator, Voice Recorder/CD player, Braille Printer/Embosser, Speech Synthesizer, Magnifying Glasses, Tactile Image Enhancer and Single Handed Keyboard. The technologies mentioned by participants clearly show that UCC has auditorybased technologies and magnifiers that assist students with visual impairment in their academic work but most of the high tech devices are still lacking.

Data emanating from participants interviews show that students with visual impairment have preference for the assistive technology they consider as important for their academics and thus neglecting or hindering their access to these assistive technologies denies them the

opportunity to engage in meaningful academic exercises that make them compete equally with their sighted colleagues in the lecture theatre. Hence, giving or providing assistive technology to visually impaired students enable them to achieve the highest level of independence in their learning.

Preferred devices

From the participants' explanation of their preferred devices, Technology acceptance model (TAM) can help in the understanding of those choices. According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioural intentions, attitude, perceived usefulness of the system, and perceived ease of the system. TAM also proposes that external factors affect intention and actual use through mediated effects on perceived usefulness and perceived ease of use (Davis, 1989). Therefore, the perceived usefulness of an assistive device played a major role in students' choice of device. For instance, a student with low vision will prefer the CCTV which is a magnifying device to other devices like the braille materials which is more tactile. In the same vein, the student who is totally blind will prefer the computer with a screen reader rather than a magnifying device.

Similar to this finding was the study by Elkaseh, Wong and Fung (2016) to investigate the factors that influence the acceptance of technologies as a tool for learning and teaching by students and teachers in Libyan higher education. They concluded that perceived ease of use and perceived usefulness of social networking media are considered as the key factors in assessing the students' and teachers' behavioural intention of accepting and using elearning in Libyan higher education.

Outmoded devices

This finding is in concurrent with the work conducted in a senior high school in Kenya by Achieng, et. al. (2015) which concluded that students with visual impairment involved in their study largely relied on the use of obsolete assistive technologies such as the Braille and mirror magnifiers. Although, time and energy exertion are necessary in any academic discourse, the situation whereby a person feels that a chosen device requires a lot of energy and also wastes time at the expense of another device which produces a similar result but with little effort and time, it is likely that that person will go for the latter device. Hence, in applying this to the context of the study, participants were aware of modern devices that emit semblance of results produce by the braille and hand frame which do not take much time and energy, and thus making them to view the braille and hand frame devices usage among students as outmoded.

Modern devices that not available

The finding gives the impression that the majority of the assistive devices used in UCC for students with visual impairment has outlived their periods and are no longer relevant in this modern day world. Students with visual impairment are abreast with what happens in thriving institutions that update their resources for students with visual impairment. Even though the computers for students with visual impairment are installed with JAWS that makes reading and learning for students easier, participants complained that the rest of the devices available do not ease learning. They said that some of the devices are old and for that matter makes a person exert a lot of energy and time on it; this they feel is not the best.

Therefore, it can be said that various assistive devices are available for students with visual impairment but most of them are outmoded. A phone survey conducted with 80 people with visual impairment in Turkey to understand what types of assistive products are used and

to what extent reviewed that majority of people preferred computer with screen readers (Bengisu, 2010), so it is not surprising that students with visual impairment also prefer that. Sunrich (2006) contended from his study which was aimed at providing an overview of the various products available for library patrons with blindness or visual impairments in USA that students with visual impairments are hesitant to attend a college where adequate services are not provided, and services are not provided because there are not enough students with visual impairments to justify the requisition of new equipment. This is not the case in UCC. With a population of 30 students with visual impairment, it is evident that students are not hesitant in coming to UCC. Therefore the number is just enough for the University of Cape Coast to provide adequate and modern devices for the students.

Conclusions

Generally, the study indicated that assistive technology in the University of Cape Coast to a greater extent play pivotal role in the education of the students with visual impairment. The findings enumerated in the summary of the key findings are discussed highlighting their implication on the place the students with visual impairment's education in UCC. Consequently, students with visual impairment involved in the study remarked that the assistive devices in UCC are mainly in computer magnifiers and auditory based devices. However, since some of the devices in the resource centre are not modern and also not available, it gives the impression that UCC is not adequately catering for the needs of the students with visual impairment it has admitted. In effect, since these devices are not available and the majority are not modern, students are not privileged to incorporate modern day technologies into their studies.

Even though, students expressed that some of the assistive device are obsolete and other are not available, they continued that the available device are playing pivotal role in their education. In it real sense the available assistive device only play crucial role in the reading and writing related skills of students with visual impairment at the neglect of the mathematics and mobility development of students. Hence, it can be argued here that the assistive device does not cater for the mathematics and mobility development of students with visual impairment. Provision of the needs of students with visual impairment is likely to facilitate smooth and successive academic work of students. However, the situation whereby students' supportive measures are not implemented to sustain their education, it is likely that the upward education aimed for persons with visual impairment would be stunted.

Recommendations

The findings on the various issues in the studies examine the state of the usage of the assistive devices. From the findings, it is clear that even though the assistive devices are not in their best quality and also not modern, the few available modern devices to an extent are playing critical roles in the studies of visually impaired students. On the basis of the findings, the following recommendations are being proposed for stakeholders for consideration in decision-making in the education of visually impaired persons.

Students with Visual impairment

Being learners or students in the university setting, students with visual impairment should be involved in every discussion pertaining to their education. For this reason, it is recommended to both present and future students with visual impairment that they:

1. Should constantly search and probe for modern assistive devices coming up to aid them in their academic work.

2. Improvise with the available devices where school authorities fail to provide the needed support for their studies.

UCC Authorities

The authorities in the University of Cape Coast have peculiar duties to perform just to ensure that students with visual impairment stay committed to their education. Based on this, it is recommended for the University authorities to:

1. Provide ample resources that support visually impaired student's development in area of reading, writing, mathematics and mobility.
2. See to it that old assistive technologies are replaced with the modern technologies trending in the education of visually impaired persons.
3. Supervise and examine how visually impaired students use the available assistive technologies at their disposal.

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