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Learning based Communication Technology for Visually Impairments Students in the Digital Age

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Abstract
Introduction: The aim to this research to determine and analyze how to learning by access and utilization digital technology for high school visually impaired students (SLBN A) at Bandung City, Indonesia, because only in this school provide computer information technology specialization class, so it is important to have learning communication that is appropriate to the conditions of students who study computer technology without using visuals.
Methods: This research used qualitative with case study method, and data collection techniques use observation, interviews, and documentation. The participants consist of visually impaired students and teachers, the school principal, and a representative from the West Java Provincial Education Office.
Findings: The research findings, reveal several essential aspects of access computers for visually impaired students, such as familiar with screen readers, the ability to remember and utilize shortcuts, proficient typing skills using all ten fingers, and the use of assistive tools. Digital-based learning involves using computers and smartphones due to the various supporting software applications. All participant have the computer skill use to type word, input data to excel, email and as well as search for materials on the internet and participants reported that smartphone was used to communicate, using conference applications, and searching for information online, and some participants used it to produce creative content.
Originality: The novelty is a collaborative learning model based on communication technology for visually impaired students. Communication technology enables this collaboration through digital applications and devices that support communication and interaction between students and teachers, and interaction between students.
Keywords: Communication Technology, Screen Reader, Digital Learning, Visually Impaired Students.

Introduction
Globally, at least 2.2 billion people have a near or distance vision impairment (World Health Organization, 2023). However, they strive to acquire education, which has shifted learning methods based on printed materials to digital formats from traditional teaching (Eligi & Mwantimwa, 2017). Students with visual impairment find it easier to write and read through smartphones compared to those with braille. Furthermore, with the development of communication technology marked by the increasing use of the internet, students actively search for learning resources on various sites (Mardiana, 2020).

The increasing use of the internet promotes digital-based communication

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technology, which has changed the way humans interact, collaborate, create work opportunities, solve problems, partake in decision-making, and disseminate information (Fattah & Sujono, 2020). This has also changed the students' learning paradigm to the power of digital technology to acquire education (Simpson & Obdalova, 2014; Wrzesińska et al., 2016).

Based on the survey Datereportal carried out in Januari 2023, 5.44 or 68% of a total population of 8.01 billion people use smartphones, while 4.80 billion or 60.9% use the internet, and 6.44% or 5.16 billion are active on social media (Simon Kemp, 2023). Meanwhile, in Indonesia, it was recorded that in Januari 2023, 212.9 or 77% out of a total population 276.4 million, are internet users. This implies an increase in internet usage from the previous year, which was 10 million people or 5.2% people from total of 353.8 million cellular mobile connections were active in Indonesia in early 2023, its equivalent to 128 % of the total population (Simon Kemp, 2023). This development impacts people's lives in terms of interaction and communication in all sectors, including the educational field.

In order for visually impaired students to benefit effectively from the special education curriculum, some teaching adjustments must be made in the school environment (Genc et al., 2021, Alquraini, Turki; Gut, 2012; Nees & Berry, 2013). Acquisition of education is the right of every child, including those with visual impairments. Therefore the government makes provision for disabled students with various needs, including establishing Special School for Visually Impaired Students (SLBN A) Bandung City, Indonesia. This school is for the blind, suffer from poor vision, and have multi-disabled visual impairments. Generally, those with total blindness and low vision have similar thinking skills as students without disabilities, including communication technology such as computers and smartphones. Therefore, since 2017-2018 academic year this led to implementing a specialization class on Computer Information Technology skills for those in high school. It was developed to trigger interest according to the changing times, where advances in all fields continue to emerge, as well as adjust to the students' abilities.

Apart from the general subjects taught, this class also teaches electives consisting of four topics, namely Data Analysis, Computer Operating Systems, Internet Networks, and Computerized Implications. Subsequently, the learning process involves the use of computer and smartphones, which also act as communication media in learning. Computers used by visually impairments students, because of the screen reader software, which read out all the activities they do while using the computer. Screen reader is a text to speech system designed to be able to read displays on a computer.

Screen readers change the visual appearance on the screen into audio. Screen readers have several functions, namely reading text and graphics on a computer screen, identifying and notifying the functions of existing facilities in windows, functioning as a mouse substitute and as a pointing device (Wongkia et al., 2012). There are two types of screen readers that used on computers in this school, namely JAWS and NVDA (Sultan et al., 2015). While screen readers on smartphones are already installed on the smartphone and can be adjusted according to the needs of students with visual impairments, such as adjusting the type of voice and speed of sound (Zhu & Yang, 2024).

This can be understood with the theory of Computer Mediated Communication, which can be defined as text-based symbolic human interaction carried out or facilitated through digital-based technology (Hawamdeh & Soykan, 2021). This definition includes the internet, smartphones, text (SMS), email and video conferencing with the addition of

text. This definition means when people are actually involved in the message transaction process where the exchange medium is computerized in certain parts (Çubukçu & Kutlu, 2013). Although the definition of CMC according to Spitzberg emphasizes the exchange of messages via text, now the latest technological developments allow the exchange of messages to be carried out through various media (multimedia) which offer various options ranging from text, audio and visual which can also be present simultaneously (Stephen W. Littlejohn et al., 2012).

Visually impaired students use computers and smartphones due to the help of screen reader software (Oira, 2016). For instance, JAWS and NVDA used on computers and installed on smartphones is possibly adjusted as needed, such as regulating the voice type and sound speed (Alajarmeh, 2021; Nayak & Chandrakala, 2020). The process of disseminating information using electronic computing media, or simply referred as information and communication technology (ICT), has gaining an increase trend. is Several previous research have been completed, including the analysis on 160 students from 4 rural and urban schools in northern Malaysia. The results stated that their ICT skills for basic internet applications in terms of accessing and sharing information are at a moderate level. Conversely, advanced ICT and internet usage for communication skills are at the least and proficient levels, respectively (Umar & Jalil, 2012)

Subsequent research was carried out during the Computer Operation Program for Visually Impaired administered by a non-governmental organization in Izmir, Turkey. This qualitative research on 10 informants showed that software development and web design are necessary for vision impairment learners (Şimşek et al., 2010). Access to technology is relevant for visual impaired students because it is beneficial to them in the future in terms of developing new activities while consolidating the existing ones simultaneously (Isaila, 2014; Rony, 2017). A similar research conducted with a mixed method on 36 respondents reported that communication technology is effectively used in innovative learning. Moreover, 42% of the informants frequently used ICT, while 77.8% utilized computer technology more often than others, such as braille embossers, and tape recorders (Eligi & Mwantimwa, 2017).

Audio technologies such as text to speech, screen readers, and various other applications on smartphones and computers are extremely relevant to visually impaired students (Pradhan & Samanta, 2018). This helps reduce discrimination and creates extraordinary access to knowledge (Isaila, 2014). Generally, it is used as a tool to improve the standard of living by boosting efficiency and effectiveness including in learning (Hakobyan et al., 2013). The novelty of this study is a collaborative learning model based on communication technology for visually impaired students. Communication technology enables this collaboration through digital applications and devices that support communication and interaction between students and teachers, and interaction between students. This communication technology supports them to actively search for learning resources independently. Therefore, this research aims to find out and analyze how learning utilizes digital technology in the digital era for visually impaired students.

Methods

A qualitative research methodology with a case study design (Creswell, 2009) was utilized in this study. The research was conducted at the Special School for Visually Impaired Students (SLBN A) located in Bandung, Indonesia, due to the school's unique offering of a Computer Information Technology specialization at the high school level, which is not yet accessible to all visually impaired students in Indonesia. The participants

comprised of fifteen visually impaired students, three visually impaired computer teachers, the school principal, and a representative from the West Java Provincial Education Office, all of whom were enrolled in or employed by the Computer Information Technology program at the high school level.

Non-participant observation in the classroom and computer practice sessions during the learning process was carried out of data collection. This is in addition to interviews with students, teachers, and the school principal. Additionally, a set of eleven questions with yes or no answers was presented to visually impaired students to evaluate their ability to use computers and smartphones for learning. In the qualitative aspect, data was analyzed using data reduction, data presentation, and drawing a conclusion. Furthermore, this was followed by testing for validity using source triangulation, i.e., cross-checking the data obtained from multiple sources.

Results

The curriculum structure of Special School for Visually Impaired Students (SLBN A) Bandung City was formulated by taking the following issues into account. First, it is designed in accordance with national standards implemented by the government. Second, its content consists of 60% to 70% academic aspects and 30% to 40% vocational skills. Furthermore, based on these provisions, an assessment was organized both internally and externally. The internal assessment comprises several qualities, such as observing and evaluating the students' readiness to participate in learning and the teachers to teach, facilities, and infrastructure, including accessible software and devices. For external assessment, there is assistance from outside the school, such as the university, in preparing the curriculum to accommodate Computer Information Technology skills. Therefore, this school provided a computer information technology skill in 2017 to support the students in the academic field.

To meet the set target, the curriculum also needs to adapt to their talents and interests. As previously explained, an assessment is also established as an initial selection process. In practice, the curriculum structure needs to capture, parse linearity and make efforts to stimulate talents and interests from an early age, therefore a program is held from the beginning. There is a formal assessment in collaboration with psychologists, standardized tests based on intelligence and other attributes. Furthermore, non-formal evaluator processes in the form of observations, written and practical exams are carried out by teachers. These various assessments are performed to fulfill the triangulation process. For example, some students interested in the choice of computer skills do not possess the required talents.

The aforementioned explanation implies that for one to enroll in the Computer Information Technology Skill Specialization class it is imperative to follow the existing assessment process. This aims to ensure that students with poor vision and the blind ones select this specialization while excluding those with MDVI (Multiple Disable Vision Impairments). Based on the interview results with informants, Teachers make efforts to bring out the potential that exists in students with visual impairments behind their limitations by adjusting to the digital era, where technology continues to develop, so that by providing schools with computer information technology skills, they can also use technology. For this reason, the school tries to build a curriculum that is in accordance with the talents and interests of students with visual impairments and adapts to the needs of the labor market later, adapting to the skills required by the company, so that later

graduates from Special Senior High School (SLBN A) can work in various sectors and develop their abilities just like normal students.

The observations results indicate that certain students do not have their monitor turned on while using the computer. While this may not pose any difficulties for students who are completely blind, those with low vision may still attempt to turn on the monitor. Figure 1 shows a visually impaired student using a computer with an unlit monitor screen.

Figure 1. Visually Impairments Students are using computers in the SMALB computer practice room (source: Research Documentation)

Figure 1 shows visually impaired students who are not using earphones and appears to be lowering their head towards the speaker while the monitor screen is unlit. Therefore, to focus better and hear the sound from the computer, they lowered their head toward the speaker. This figure is further explained by the statement from the informant *"I have low vision, and even though I can use the computer with the monitor on, I can only see a little bit. Hence, it is also okay for me to use a computer with an unlit monitor, as long as the sound is clear."* Furthermore, an informant also described the monitor screen when using a computer, as follows *"I am completely blind, therefore, it doesn't really matter if the monitor is off when using a computer the important thing is having a clear sound using earphones."*

The following are the findings from interviews conducted with student informants regarding the use of computer monitors. According to the informants, students with total visual impairments do not require a monitor to use a computer, whereas those with low vision can still use a monitor even though they are accustomed to using it without having the monitor. Furthermore, the research findings, which encompassed interviews, observations, and various documents, reveal several essential aspects of using computers for visually impaired students. These include the importance of being familiar with screen readers, the ability to remember and utilize shortcuts, proficient typing skills using all ten fingers, and the use of assistive tools like speakers, earphones, or headsets.

A screen reader is the first thing that needs to be understood by students with visual impairments to learn computers, the computers we use are the same as normal ones used by people without visual impairments. Students with visual impairments should also master basic computer skills such as memorizing keyboard shortcuts and the location of letter keys since they cannot use a mouse. For example, when opening a file using the shortcut 'Ctrl + O,' they must know the location of the 'Ctrl' key and the 'O' key on the keyboard. Every button pressed produces a sound, allowing users to determine if what they typed is correct or wrong. The sound is possible because of the screen reader software installed on the computer. During observations made in a computer practice room, some students exemplified using keyboard shortcuts, such as 'Ctrl + up arrow' to read one

paragraph above and ‘Ctrl + down arrow’ to read one paragraph below. Similarly, using the ‘up arrow’ key to read one line above and the ‘down arrow’ key to read one line below.

The students’ ability to memorize shortcuts shows that blind students have good cognitive abilities, and strong memory, specifically those not born blind. Earphones and headsets are indispensable technological tools for students while using computers. They aid in hearing sound from devices such as computers and smartphones, without disturbing others. Students have acknowledged that turning up the volume, using earphones or a headset, is a crucial tool while using computers, as it helps them focus more, without needing to stand closer to the computer speakers. The research results on how students with visual impairments access technology are shown in Figure 2:

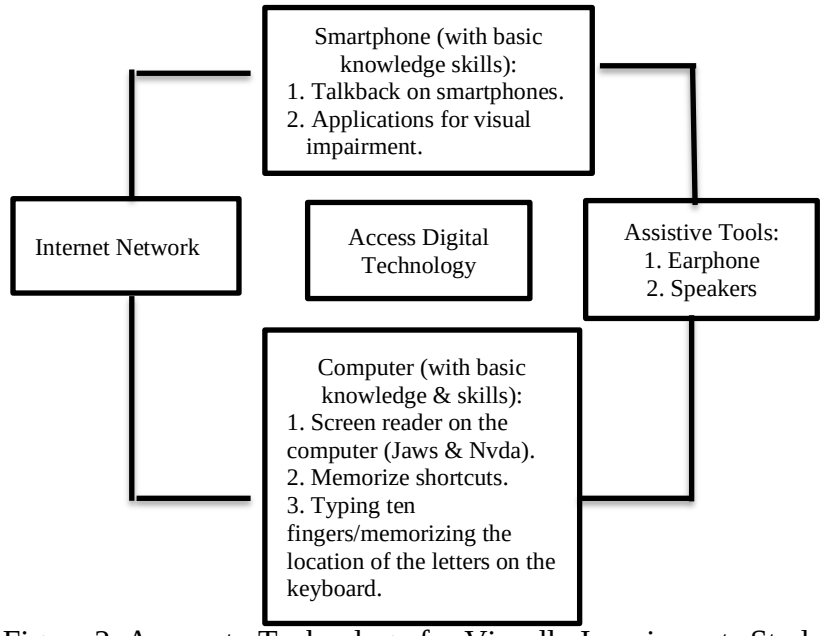

Figure 2. Access to Technology for Visually Impairments Students
(source: Based on Result Research)

Computers and smartphones are communication technologies that are extensively used in computer specialization classes for learning purposes. Blind students have provided valuable insights regarding the essential basics of computer usage, which include comprehending screen readers, memorizing and employing keyboard shortcuts, typing using all ten fingers, and utilizing speaker aids, earphones or headsets. The use of other assistive devices such as earphones or headsets helps them focus more on hearing the sound emitted from the device, specifically the screen reader.

The academic process takes place in 2 forms, namely face-to-face and internet-based learning, using a smartphone device. Face-to-face learning involves direct communication through spoken and written braille. The teacher explains the subject matter while the students respond orally. Sometimes they use braille when noting the teacher’s explanation to be able to practice it using spoken (voice) terms. In accordance with the internet-based procedure, communication takes place through various media. For example, when the teacher is unable to attend classes, the assignment is conveyed through WhatsApp. Once the students complete their task, it is sent back through the same medium in text, images, and voice notes, or email. Subsequently, smartphones are also used when learning is carried out remotely, namely through conference calls. This has been conducted with informants from external parties, namely visually impaired students

in Computer Information Engineering with exceptional technology skills. Figure 3 below shows the use of WhatsApp during learning.

Figure 3. Learning through Whatsapp Social Media
(source: Documentation from Informant (Student (Yng)))

The use of other media, asides from WhatsApp and email, is also carried out through the team talk application, which is downloaded from the Play and App stores for android and ios-based smartphones. This application allows its users to interact, in real-time, such as by chatting directly. In contrast to WhatsApp, sometimes there is a time lag when the message is not read or replied to immediately by the message's recipient. Subsequently, each class creates its channel. The only interaction that is performed is voice communication, as reported by informant: *"We use a dedicated server in the team talk application, therefore, we do not mix with users from other countries. Furthermore, several folders were named according to the buildings and rooms in the school, enabling students to follow the usual lesson schedule. Therefore, students should not worry about getting enrolled into the wrong class when learning to use a smartphone."*

The team talk conference application is one of the learning technologies used in the digital era by totally blind students and those with low vision because it is easily accessible. Communication takes place through the direct voice, however there is no camera display. Moreover, during learning, students enter the class in the team talk application according to the lesson schedule, as shown in Figure 4:

Figure 4. Internet-based Learning through the Team Talk Application
(source: Documentation from Informant (Student (Ctl)))

The learning process in the computer information technology skills specialization class does not always run smoothly. However, certain obstacles in the form of technological barriers, such as when the screen reader on the computer is off or the internet network has interference and bad signal, are encountered during the cause of teaching. Besides, this is the main tool in a computer or smartphone used by visually

impaired persons. Another barrier is the inability of computer software to describe images, thereby limiting the screen reader to the written numbers. These results are further shown in Figure 5 below:

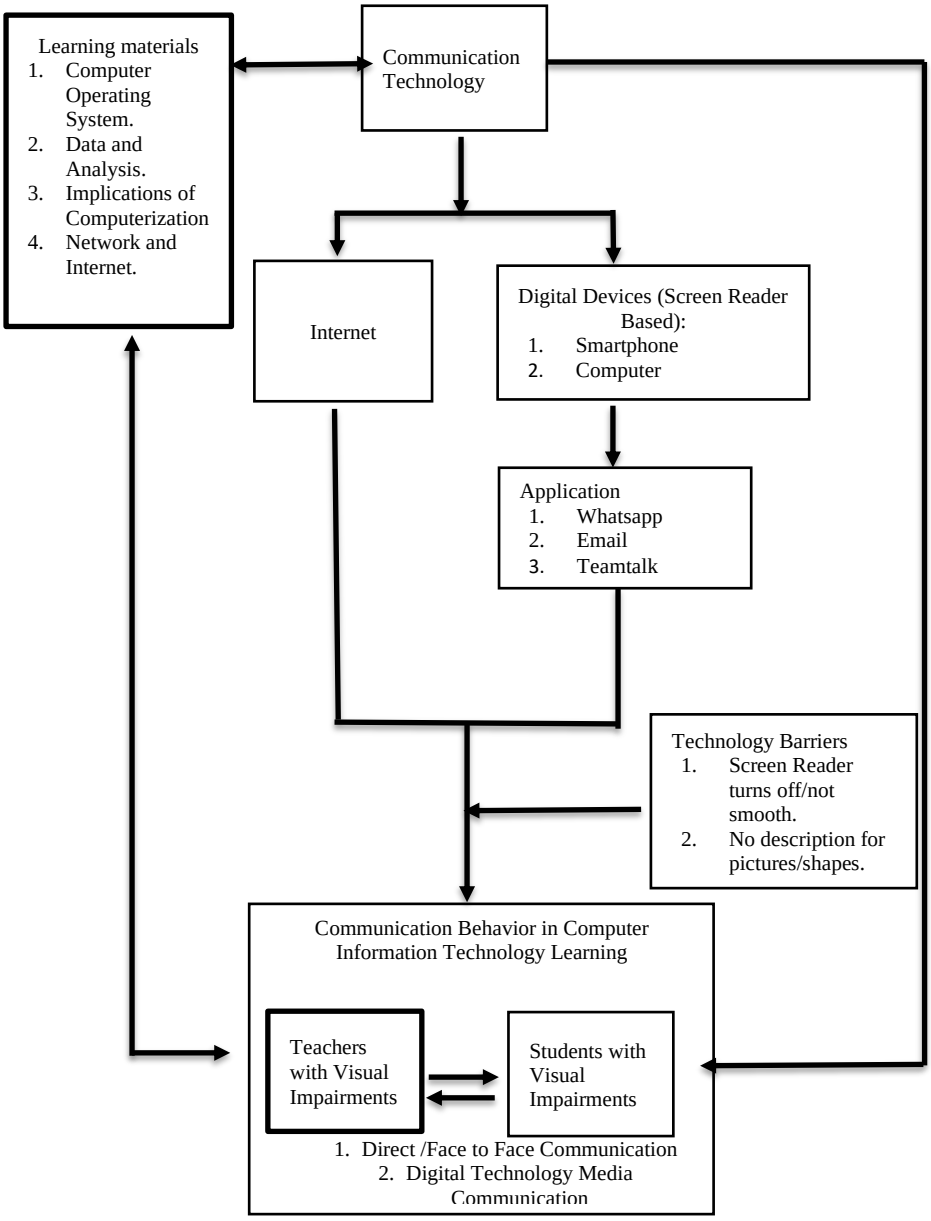

Figure 5. Learning process for students with visual impairments in the Digital Era (source: Result Research)

In Figure 5, learning materials are not only obtained from teachers, they are also found on the internet. Other means include sharing information with friends using communication technology in smartphones and computers, thereby enabling visually impaired students to be more active and not always dependent on the tutor. To obtaine a comprehensive description of learning in computer information technology specialization classes, this research also provides a yes-no answer questionnaire to participants regarding the relevant devices used in learning. Furthermore, the results are shown in the following table:

Table 1. Communication Technology Use in Learning on Visually Impairments Students

		Yes	No
Computer Use	Doing MS Word Typing.	15	0
	Enter data in columns and rows using excel.	15	0
	Perform numerical data analysis using the sum formula, etcetera.	9	6
	Write presentation slides using PowerPoint.	10	5
	Read messages, write and email schoolwork.	15	0
	Searching for information on the internet.	15	0
	Producing creative content (for example, YouTube content, streaming radio, and blog).	6	9
Smartphone Use	Use social media, such as WhatsApp, team talk, Facebook, etcetera for communication.	15	0
	Search Information on the internet.	15	0
	Using conference applications, such as team talk, zoom, and google meet.	15	0
	Produce creative content, such as YouTube content, streaming radio, and blog.	6	9

Note: the study surveyed 15 visually impaired student for descriptive analysis.

In Table 1, it is evident that for computer use, all participants with visual impairments have the skill to type MS word, input excels data, read messages, write and send school assignments emails, as well as search for materials on the internet either independently or based on the teacher's directives. However, to analyze numerical data using excel, as many as 60% of the students stated they possessed the knowledge or skill. Furthermore, 66.6% stated that they were able to use PowerPoint, although this was limited to writing, and not in the form of image design because there was no description on the computer, therefore, they found it difficult. 46.6% of the participants then reported that they were able to produce creative content about information and communication technology which was uploaded on YouTube and accessible to visually impaired students. This shows that they are indeed happy to learn and love to share these benefits with others through these contents.

Another device used is the smartphone because it is brought to school and owned by all participants. Meanwhile, all of participants reported that this device was used to communicate through social media WhatsApp, team talk, and Facebook. The conference applications such as zoom, team talk, Google meet, and searching for information online are also used for digital-based learning (John, 2020). However, as is the case with computer use, 46.6% of the participants used it to produce creative content, uploaded on YouTube channel, with other tools such as speakers and headsets or earphones.

Discussion

People with visual impairments can benefit from computer and smartphone technology through various software and applications that support them. One crucial application or software that they should have is a screen reader, a text-to-speech system specifically designed to read computer displays (Morissan, 2020; Mahajan & Nagendra, 2014). The screen reader works by converting visual displays on the screen into audio output, enabling visually impaired users to interact with their devices (Christensen & Ph, 2000). Some of the essential functions of a screen reader include reading text and graphics on the screen, identifying and notifying the functions of facilities on windows, identifying graphics, serving as a mouse replacement, and functioning as a pointing device (Wongkia et al., 2012).

A screen reader is capable of reading out all computer activities, as was observed during a data and analysis class held in a computer practice room. During the class, students from Class X were tasked with typing the phrase 'Weather News,' and the screen reader proceeded to read each letter aloud, including the spaces between the words 'w, e, a, t, h, e, r spaces n, e, w, s.' Therefore, when a student with a visual impairment makes a typing error, they will be immediately alerted by the mismatched letters read out by the screen reader. For this reason, they need concentration and focus on hearing the sound from the computer while using the computer (Fichten et al., 2009a).

JAWS and NVDA are two screen reader software used in the computer practice room at SLBN A in Bandung City. JAWS, which stands for Job Access With Speech, is the most widely used screen reader software worldwide. It is designed to assist computer users with visual impairments to access screen content and navigate using a mouse. JAWS provides voice and braille output for popular computing applications on PCs, including reading documents, emails, websites, and applications. Apart from JAWS, another screen reader software is NVDA. Based on the results obtained from the interview, learning in this class involves using computers and smartphones due to the various supporting software applications, such as screen readers, etcetera (Edumadze et al., 2022). Meanwhile, those on computers are NVDA or JAWS, while for smartphones, it is talkback for android and voice-over for IOS. Computers and smartphones are communication technologies that are widely used in specialization classes. However, other tools such as earphones or headsets that help them focus on the device's sounds (screen reader) are also employed.

Learning in the digital era shows changes in educational patterns that are not only teacher-centered, but learning resources can also come from internet sources that can be accessed by students independently (Mohd Saiboon et al., 2021). The devices used in the form of computers and smartphones, supported by the internet and other tools, are important in the learning process of students with visual impairments (Christensen & Ph, 2000; Laabidi et al., 2014). Learning with digital technology can also be done in a blended or hybrid way, face-to-face in the classroom as well as online through social media or using a conference application (Suminar & Trisyani, 2012; Mukarom & Rusdiana, 2017).

Computers and smartphones, supported by the internet and other technological tools, are relevant media for visually impaired students. This is because learning is either accomplished under the teacher's guidance or by independently searching for the materials (Johari et al., 2022). This shows that the changing education pattern is not only teacher-centered, rather certain resources are also obtained from the students. This class also tends to be performed in a blended or hybrid manner, face-to-face in the classroom as well as online through the media (Fattah & Sujono, 2020). According to Ploma,

communication technology is characterized by the following, namely (a) there are various flexible tools, (b) combining different methods and systems thereby creating new forms of communicative processes, and (c) the tendency towards decentralization and individualization based on users' concepts, and patterns (Ludíková & Finková, 2012).

ICT is also a medium for delivering messages in the digital era and facilitates access and information sharing, as well as aid students to develop their talents and interests such as the results show that the visually impaired respondents create content about technology uploaded on blind media YouTube accounts (Hakobyan et al., 2013; Bilyalova et al., 2021). Subsequently, some used computers to write short stories and participated in its competitions. The independent research of this device at school is beneficial.

Technology, specifically smartphones, tend to transform ways to access shared knowledge sources by constantly connecting to near-infinite volumes of data and information (Mardiana, 2020). This research finding that the ability to use a smartphone is obtained independently or obtained from friends and various communities participated by the students, while the ability to use a computer as an elective subject is mostly obtained from classroom learning (Pheeraphan, 2013; Fichten et al., 2009), so it is like previous research that visually impaired students study computer information technology by a sense of self-determination, collaboration, and personal development (Retorta & Cristovão, 2017; Osiceanu & Popa, 2015). When we look at findings, the barriers to learning in the digital era are technological barriers. As long as software and hardware are designed and built without considering their accessibility, and as long as accessibility is not a major consideration when developing and purchasing higher education e-learning products, the problem of accessing e-learning will continue to exist (Fichten et al., 2009b).

Conclusion

In the digital age, the internet and communication technology such as smartphones and computers are used as learning media for visually impaired students. Moreover, Special School A Bandung City realizes the importance of this subject, including its ability to boost their active role, helping them to access information as a medium of communication, and develop their talents and interests, thereby making them adaptive to technology. It serves as a third eye when properly learnt, and helps to overcome limitations.The Computer Information Technology Skills specialization class is recommended to serve as a reference for other special schools, and it certainly adapts to the students' needs. Furthermore, it takes absolute commitment from various related parties, such as the government, companies, or individuals. Observers of social problems, especially disabilities, develop communication technology that suits the needs of these students, such as perfecting computer tools to describe shapes and images, thereby causing them to remain adaptive to technology and continue to be creative to achieve a better future.

Conflict Interest

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

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