People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

University of Batna 2

Faculty of Letters and Foreign Languages

Department of English Language and Literature

The Impact of Using Assistive Technology on Reading Speed Rate of English as a Foreign Language among Students with Visual Impairments A Case Study of Braille Club at El Oued University and Students with Visual Impaiement School in Robbah

Thesis Submitted in Partial Fulfillment of Requirements for the Degree of

LMD Doctorate in Teaching English as a Foreign Language (TEFL)

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2022/2023

Declaration

I, Soumia TAMMA, a PhD candidate, hereby declare that this doctoral thesis entitled **"The Impact of Using Assistive Technology on Reading Speed Rate of English as a Foreign Language among Students with Visual Impairments. A Case Study of Braille Club at El Oued University and Students with Visual Impaiement School in Robbah"** is my original work. It has not been submitted to any other university or institution for publication or certification. All the sources and references used in this research are fully acknowledged and cited using the APA 7th edition referencing style. I understand the ethical implications of my research, and this work meets the requirements of the Faculty of Letters and Foreign Languages.

Candidate: Miss. TAMMA Soumia

Signature:

Dedication

A special feeling of gratitude to:

My loved parents

Your words of encouragement and push for tenacity ring in my ears.

My faithful brothers and sisters

Thank you for your everlasting love and support.

My dear friends and all people in my life who touch my heart

Unfortunately, I cannot thank everyone of you by name because it would take a lifetime.

However, I am eternally grateful to all of you for the unforgettable moments we shared together.

I want you all to know that you count so much to me.

Me

For the countless and arduous sacrifices that I spent.

Acknowledgments

First and foremost, my first tremendous and eternal gratitude is addressed to Allah the Almighty, who always blessed and guided me in every strenuous work and problem in my life.

I wish to express my sincere gratitude to my supervisor, **Pr. Nadir KAOULI**, for his assistance throughout the stages of my PhD journey. I am also indebted to my co-supervisor, **Pr. Mohammed NAOUA**. My special appreciation goes also to the members of the jury: **Dr. Salim Ounis** and **Dr. Nacira GHODBANE** who accepted to examine and evaluate my work .

I would also like to thank the headmaster of the Robbah School for Visually Impaired Students, **Mr. Djamal TLITLANI**, who allowed me to conduct this research in his school. My best thanks are also to the visually impaired students who were always willing to participate in my study.

My gratitude is also extended to **Pr. Omar GHOUAR**, **Pr. Amel BAHLOUL**, **Pr. Mohamed Salah NEDJAI**, **Pr. Hachemi ABOUBOU**, **Dr. Radia GUERZA**, **Dr. Riadh MEGUELLATI**, **Dr. Tahar GOLEA**, **Dr. Abdelaziz AGTI**, **Dr. Charif BEN BOULAID**, and **Dr. Farida LEBBAL**. I thank them for their constructive teaching and assistance in overcoming technical problems while conducting my study.

In addition, words cannot express my appreciation for **Pr. Adala LADJAL** at Mostaganime University, **Dr. Wassila OUAAR** at Batna 1 University, **Dr. Naima KHATIR** at the University Center of Naama, and **Dr. Doaa HAMAM** at Higher Colleges of Technology in Abu Dhabi, United Arab Emirates, all of them never stopped providing me with valuable feedback.

Last, but not least, thank you to my colleagues and the PhD candidates who supported me in doing this research.

Abstract

This study aims to explore the impact of using assistive technology (AT) on reading speed rate of English as a foreign language (TEFL) among visually impaired students (VIS). Previous studies published limited evidence in teaching reading English for VIS due to a lack of research. In this study, stratified random sampling included six participants from each stratum ($n_1 = 6; n_2 = 6$). They were enrolled at Robbah School for SVI and EL-Oued University for 2020/2021. This research adopted the exploratory sequential approach to address the research questions. On the one hand, the thematic analysis of semi-structured interviews revealed that respondents from Robbah School for SVI lacked resources, knowledge, and training in using AT. In contrast, the VIS of EL-Oued University used various assistive technology tools. Therefore, they experienced accessibility to printed information, minimized over-dependence on sighted students, and had a positive attitude toward using AT for English learning. On the other hand, the pre-test and post-test statistical analysis showed statistical significance. Accordingly, the average reading speed of VIS of El-Oued University participants using an electronic Braille display (M = 64.17, SD = 8.612) was significantly greater than the average reading speed using Braille paper (M = 56.83, SD = 8.495), $t(5) = -22.0021$, $p = 0.000003603$. In contrast, the mean reading speed of Robbah School for SVI participants in the post-test (M = 36.33, SD = 13.337) was significantly smaller than the results of the pre-test (M = 51.33, SD = 12.956), $t(5) = -5.78$, $p = 0.00218$. Subsequently, both mean populations average was significantly different (μ_2=M = 36.33, SD = 13.337; μ_1=M = 64.17, SD = 8.612), $t(10) = -4.295$, $p = 0.0016$ at the α=0.05). Consequently, pedagogical recommendations were proposed for further research.

Keywords: Assistive Technology, Reading Speed, Students with Visual Impairment, Teaching English as a Foreign Language.

List of Tables

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List of Abbreviations

1st	First
2nd	Second
3rd	Third
A	Alpha
i.e.,	The Latin phrase “id est” means “that is”
M	Mean
P	Probability Value
SD	Standard Deviation

List of Acronyms

AFP	American Foundation for the Blind
AT	Assistive Technology
EFA	Education for All
EFL	English as a Foreign Language
ELT	English Language Teaching
ESL	English as a Second Language
FL	Foreign Language
ICT	Information Communication Technology
IDEA	Individuals with Disabilities Education Act
JAWS	Job Access With Speech
LD	Learning Disabilities
SVI	Students with Visual Impairment
TEFL	Teaching English as a Foreign Language
TVIs	Teachers of Visually Impaired Students
UN	United Nations
UNESCO	the United Nations Educational, Scientific, and Cultural Organization.
VI	Visual Impairment
VIS	Visually impaired students
WHO	World Health Organization
WPM	Word Per Minute

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Introduction

This introductory chapter contains eleven significant sections, namely (1) background of the study, (2) statement of the problem, (3) research objectives, (4) research questions, (5) hypotheses of the study, (6) purpose of the study, (7) the significance of the study, (8) delimitations of the study, (9) research limitations, (10) research methodology design, (11) theoretical framework, (12) operational definitions of the key terms, and (13) structure of the thesis.

1.1. Background of the Study

Sight holds immense significance (Kauffman, Hallahan, & Pullen, 2017). In their study, Abdullah, Jani, and Abdullah (2012) showed that people process approximately 80% of their learning through visual perception. Hence, sight sense is essential for constructing knowledge about the world. For this reason, the eye is a significant organ for visual information (American Optometric Association, 2010; Jayakody, Lokuliyana, Sampath, Silva, Rajanthika, & Seneviratne, 2016; Khadka, Ryan, Margrain, Woodhouse, & Davies, 2012).

Unfortunately, people with vision impairments have significantly reduced vision levels that influence their ability to perform their daily tasks. “Visual Impairment” (VI) refers to a functional deficiency of vision due to known or unknown disorders or diseases on the level of the eyes. This disability results in a functional limitation of the visual system (Geraci, Ashton, Kuykendall, Johnson, & Wu, 1997). Visual impairments influence the quality of individuals’ life. Hence, a VI may result in a disability that significantly interferes with one’s ability to

function independently of the day-to-day aspects of life and move safely into various riots environments (West, Rubin, Broman, Munoz, Bandeen-Roche, & Turano, 2002).

In 1992, the World Health Organization (WHO) introduced a functional component to the definition of visual impairment. It encompasses two primary classifications of visual disabilities, spanning from moderate visual impairment to severe cases of complete blindness. The WHO (1992) defined a low-vision individual as "one who has impairment of visual functioning even after treatment and refractive correction and has a visual acuity of less than 6/18 to light perception, or a visual field of less than 10° from the point of fixation" (WHO, 1992, pp. 23-24). On the other hand, blindness is a condition characterized by a person's visual acuity being below 20/400 and a complete inability to perceive any light (WHO, 2004).

In 2001, the World Health Organization (WHO) established a classification system to categorize visual impairments based on the extent of visual loss. This classification depends on, but is not limited to, two basic tests (a) the score of visual acuity and (b) the degree of the visual field (WHO, 2001). This medical view depends on the "best-corrected" vision test. This latter refers to the value of visual acuity (VA). For example, visual acuity score of 20/20 represents the traditional standard value for normal acuity. The VA stands for the clarity or sharpness of vision (Elliott, Yang, & Whitaker, 1995).

In 2004, the Individuals with Disabilities Education Act (IDEA) officially defined visual impairment from an educational perspective as "an impairment in vision that, even with correction, adversely affects a child's educational performance. The term includes both partial sight and blindness" (IDEA, 2004). Approximately 90% of visually impaired persons, especially

children, may be deprived of their right to education due to their visual impairment (Holden, 2007).

The issue of teaching visually impaired (VI) learners, in one form or another, has been associated with changes occurring in specialized educational settings (Al-Zyoudi, 2006). For SVI, special education has often provided educators with "extra" or "different" methods to address special educational needs. For example, educators may adjust their teaching techniques for non-disabled learners using adapting instructional materials (Fuchs & Fuchs, 1995).

On the other hand, inclusive education provides "all" learners, including disabled students, equal education rights (Winter, 2006). The ultimate goal of inclusive education is to ensure access, participation, and achievement for all students, with teachers playing a pivotal role in making this happen (UNESCO, 2018). For this purpose, there is a need to adapt their educational tools (Dimigen, Roy, Horn, & Swan, 2001).

In contemporary society, the education system recognizes the fundamental importance of incorporating foreign language teaching and learning (Malinovská & Ludíková, 2017). According to Jedynak (2018), the beginnings of interest in foreign languages (FL) teaching of VISs dates back to the 1930s. Morrissey (1931) explained the potential of blind people in FL learning in his book *Teaching Foreign Languages in Schools for the Blind*. Nowadays, the demand for teaching English as a foreign language (TEFL) is due to the emergence of English as a global language as an aspect of communication worldwide. One reason is that technology has shrunk the physical world into a "global village." As a result, learning languages has become increasingly necessary (Tiersky & Tiersky, 2001). Students with visual impairments (SVI) often experience challenges perceiving visual information directly from their environment.

Therefore, there is a need to adapt instructional materials to suit the special educational needs of VI learners (LaVenture, 2007). In this context, visual impairment results in "using alternative skills and tools in place of, or in addition to, eyesight to gain information or perform tasks" (2005, p. 16). Therefore, adapting instructional materials for learning disabilities (LD) students is critical. Accordingly, there was a tremendous tendency to integrate new and modern instructional study materials with constant technological advancement to ensure greater adaptability for visually impaired learners.

Historically, the use of technology for learners with LD provides them with a variety of adaptive devices and services to meet the special educational needs of LD learners. These technology resources intentionally attempt to assist students with physical impairments such as visual impairments (Edyburn, 2004). Nevertheless, students with LD use the appropriate assistance educational tool such as adaptive technology. Then, they can succeed in academic fields such as learning a foreign language. Nevertheless, the success of VI learners in foreign languages depends on three aspects. (a) language teachers, (b) visually impaired learners' traits, and (c) tailoring language education provision (Jedynak, 2018).

Assistive Technology (AT) refers to any device or system utilized by individuals to overcome challenges or complete tasks that may otherwise be difficult or unachievable. The World Health Organization (WHO) emphasizes that the primary goal of AT is to uphold or enhance an individual's functioning and independence, promoting participation and overall well-being. Additionally, AT can play a role in preventing impairments and secondary health issues.

In education, AT provides effective instructional assistance for individuals with disabilities, such as SVI, by enabling them to overcome or offset their limitations (Raskind & Stanberry, 2008). This view, according to Chung (2009), indicates "there is a wide belief that AT

may compensate for lack of sensory or physical ability that inhibits access to traditional instructional modalities" (p. 10). For instance, a piece of the scotch tape becomes an AT tool when LD students with only one hand can use it to stabilize the paper (Coleman, 2011).

According to Hersh and Johnson (2008), it becomes possible to adapt modern instructional materials or meet all learners' needs in foreign language teaching, including those with VI. For example, low-vision students can access printed information using AT resources such as audio transcriptions and tactile methods, while electronic information (Hersh & Johnson, 2008). Conversely, the main AT tools used for visually impaired learners to access textual information "speech synthesizers" and "Braille cell displays or embossing printers" (Shimomura, Hvannberg, & Hafsteinsson, 2010, p. 297). Braille, invented by Louis Braille in the early 1800s, is the primary literacy medium and is a tactile phonetic alphabet system for blind or visually impaired individuals (Lowenfeld, 1968).

During the digital revolution, Braille literacy has undergone significant changes, as many Braille readers now utilize technology like refreshable Braille displays for access. However, there remains a scarcity of studies exploring instructional methods for teaching Braille literacy (Ferrell, 2006; Luckner, Bruce, & Ferrell, 2016), and even fewer examine the efficacy of technology in facilitating Braille literacy education (McCall, McLinden, & Douglas, 2011). Further research is needed to assess the impact of assistive devices on the academic performance of blind or visually impaired children and youth (Freeland, Emerson, Curtis, & Fogarty, 2010).

1.2. Problem Statement

Foreign language teaching and learning focus on visual input as the primary instructional tool (Pateşan, Balagiu, & Alibec, 2018). For example, pictures and videos could connect mother tongue meaning to English. In this case, direct translations would not be necessary (Feuntein

1995). Accordingly, the visual materials could support teachers in making the input comprehensible for the students (Carney & Levin, 2002) and assist educators in correlating accurate concepts, making the learning more concrete (Mannan 2005, p.108). In this light, vision plays a significant role in communicating the meaning of a target language.

However, visually impaired students encounter difficulties learning foreign languages because vision services are a meaningful stimulus (Agesa, 2014; Arslantaş, 2017). Consequently, reading difficulty is one of the significant consequences of vision loss because reading fluency requires the ability to read with speed, accuracy, and expression (Rasinski, 2006). Braille readers read at about half the rate of print readers, at about 150 words per minute (Pring, 1984).

In the era of the digital revolution, the integration of Information, Communication, and Technology (ICT) has become a global requirement to replace traditional teaching methods with technology-based teaching and learning tools (Ghavifekr & Rosdy, 2015). Accordingly, the use of ICT in teaching and learning foreign languages has risen sharply in the educational community (Negoescu & Boştină-Bratu, p. 21, 2016). In the same vein, as a part of the ICT spectrum, assistive technology (AT) consists of many devices and services (Mordini et al., 2018).

Typically, the hard copy of printed Braille paper was the primary tool for reading in the pre-digital era. Nowadays, assistive technologies for reading provide auditory or tactile access to printed or digital text in Braille formats. For example, screen-reading software converts digital text into synthetic speech, and reading display devices such as portable note-taking devices aim to support visually impaired students' literacy. Although few braille readers could read at speeds comparable to the average print reader, most of them read between one-third and one-half as

quickly as their sighted peers (Ferrell, Mason, Young, & Cooney, 2006; Legge, Madison, & Mansfield, 1999; Morris, 1966; Simon & Huertas, 1998).

1.3. Research Objectives

This research aims to address the following objectives.

1. To identify the AT tools that visually impaired students (VIS) use to learn English as a foreign language (EFL).
2. To determine the challenges facing visually impaired learners while using AT materials in EFL learning.
3. To compare the impact of using printed Braille paper or an electronic Braille display by visually impaired students at EL-Oued University on the reading speed rate of English.
4. To compare the impact of using printed Braille paper or an electronic Braille display by visually impaired pupils at Robbah School for SVI on the reading speed of English.
5. To compare the impact of using an electronic Braille display on the reading speed of English between visually impaired pupils at Robbah School for SVI and visually impaired learners at EL-Oued University.

1.4. Research Questions

The following central research questions (RQ) guided this study:

RQ 1: What modern assistive technology tools are used for EFL learning?

RQ 2: What challenges did they face while using modern assistive technology for English learning?

RQ 3: Does using printed Braille paper or an electronic Braille display significantly impact the reading speed rate of English among visually impaired students at EL-Oued University?

RQ 4: Does using printed Braille paper or an electronic Braille display significantly impact the reading speed rate of English among visually impaired pupils at Robbah School for SVI?

RQ 5: Does the use of an electronic Braille display have any significant difference between visually impaired pupils at Robbah School for SVI and visually impaired learners at EL-Oued University on the reading speed of English?

1.5. Hypotheses of the Study

The current study is based on the three following non-directional hypotheses:

H_{01}: There would not be a significant impact between the reading speed of English using Braille paper or an electronic Braille display among visually impaired students at EL-Oued University.

H_{02}: There would not be a significant impact between the reading speed of English using Braille paper or an electronic Braille display among visually impaired pupils at Robbah School for SVI.

H_{03}: There would not be a difference existed between visually impaired students at Robbah School for SVI and visually impaired learners at EL-Oued University in the reading speed of English using a an electronic Braille display.

1.6. Rationale of the Study

This research w driven by the need to:

- **Educational Equity**: The study aims to address the educational equity and inclusion of visually impaired students by investigating the impact of assistive technology on their English language learning. This research seeks to ensure equal opportunities for visually impaired students to access educational resources and succeed in their language studies.
- **Limited Research**: Previous studies have highlighted the lack of research on teaching English to visually impaired students using assistive technology. By conducting this study, we aim to contribute to the existing knowledge base and fill the research gap in

this specific area, providing valuable insights for educators, policymakers, and researchers.

- **Empowering Visually Impaired Students**: The use of assistive technology has the potential to empower visually impaired students by enhancing their access to printed information, reducing dependency on sighted peers, and fostering independence in language learning. This study seeks to explore the benefits and challenges of assistive technology tools in supporting visually impaired students' English language acquisition.

1.7. Purpose of the Study

The current study explores the students' experiences with visual impairment and how assistive technology (AT) use affects the teaching process of English as a foreign language (TEFL) at El-Oued University and Robbah School for SVI. This purpose arose from the realization that VI students are significant determiners in understanding their perspectives in applying AT in educational contexts. Besides, this inquiry examines the nature of that impact on the reading speed of English quantitatively. Therefore, data obtained may make additions to the existing stock of knowledge.

1.8. Significance of the Study

Understanding the impact of assistive technology use would support the exploration of the reality of AT potential in teaching EFL for visually impaired learners. This goal can provide a clear understanding supported by learners' points of view. Thus, capturing the VISs' experiences is essential for engaging them in decision-making.

Practically, for teachers of visually impaired students (TVIs), this study is expected to give insights into understanding the AT impact on reading accuracy. In light of this objective, TVIs would evaluate the AT tools outcomes in teaching reading for EFL learners with VI.

Hence, they (TVIs) would bridge the cons of AT resources and reinforce their pros. In this view, this study may benefit English teachers by promoting SVI's quality of the TEFL process. Then, TVIs can raise their awareness of the potential of applying assistive technology in teaching English as a foreign language. As a result, they could clearly understand the impact of using AT as educational resources to meet VISs' needs during TEFL.

1.9. Delimitations of the Study

Delimitations of a study explain the limits that a researcher imposes before initiating research. This step is of utmost importance to narrow the focus of a study (Creswell, 2003).

First, this study focuses on using Assistive Technology as an educational tool for VISs in EFL teaching and learning. For this purpose, the concern of this current research does not include other tools of AT that relate to other forms of learning disabilities (LD). For instance, types of LD may consist of, but are not limited to, dyslexia (reading difficulties), dysgraphia (difficulties with composing writing), dyscalculia (disability to understand and learn math facts), and autism spectrum disorder (ADS).

The Second delimitation relates to the educational settings for teaching VI learners. As a result, this study exclusively focused on the educational context for teaching visually impaired students. In other words, there are two forms of educational environment for SVI. The first is special education (Robbah School for SVI), where VI learners learn only with their visually impaired peers. The second is inclusive education (EL-Oued University), in which VIS learn alongside their non-visually impaired counterparts in public education institutions.

Third, the selection of visually impaired learners has created a delimited sample size of only VISs who learn English as a foreign language. Accordingly, these research samples (two case studies) are (a) SVI from El-Oued University, representing a random sample from inclusive

educational settings. In contrast, (b) SVI from Robbah School for SVI and El-Oued University represent random samples from two educational settings (institutions) at different educational stages for VIS.

1.10. Limitations of the study

It is essential to recognize, address, and acknowledge the limitations of a study because those limitations are often inevitable in any research (Bloomberg & amp; Volpe, 2008). Consequently, it is essential to acknowledge the shortcomings of this research fully. This study encountered three main limitations.

The first limitation was the "generalizability" of the current research's findings. This fact was due to the limited sample size of SVI at both the Braille Club of El-Oued University and Robbah School for SVI. This restriction is because Robbah School for SVI was the only school for VISs as a specialized educational setting in El-Oued city. On the other hand, the Braille Club of EL-Oued University represented an inclusive educational setting of higher education with a limited number of VI students.

Second, the Ministry of National Education of Algeria adopted the same curriculum in TEFL for SVI as their sighted counterparts without any minor accommodations in the EFL courses for VISs. However, the TEFL curricula in higher education were not unique and similar in terms of the content at El-Oued University because of a wide range of departments with various specializations.

Third, during the pandemic of COVID-19, there were a set of precautions for minimizing the implications of virus spread. Thus, the Ministry of National Education and the Ministry of Higher Education and Scientific Research in Algeria implemented a new educational policy related to the regular attendance of students.

1.11. Research Methodology Design

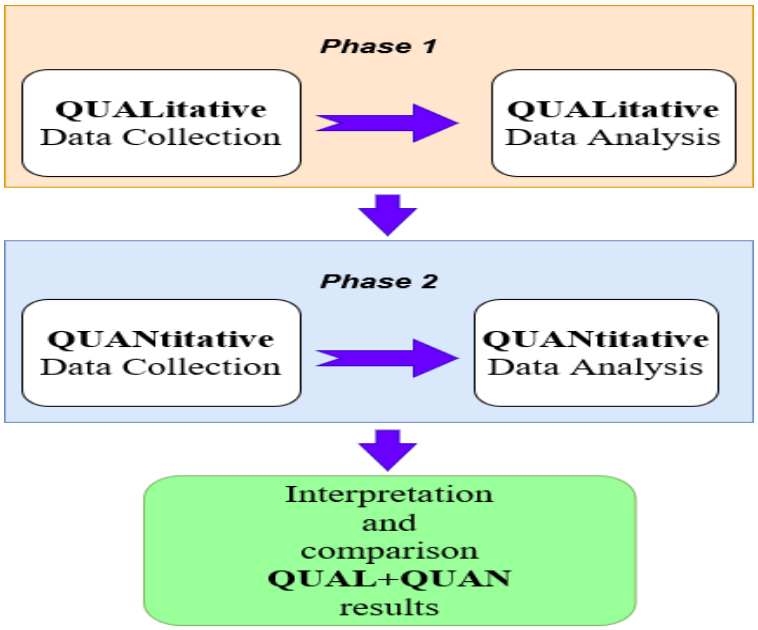
In mixed methods research, data collection strategies can be conducted sequentially or simultaneously. In this study, a sequential design was employed, which involved gathering qualitative data first, followed by the collection of quantitative data. This approach was utilized to gain deeper insights from the qualitative data and subsequently enhance the understanding of the study through the quantitative data analysis (Teddlie & Tashakkori, 2009).

1.11.1. The Exploratory Sequential Design

According to Garbarino and Holland (2009), combining qualitative research with quantitative instruments in impact evaluation could maximize a greater breadth of coverage and generalisability of data (p. 27). Quantitative methods generate data that can be collected and analyzed to describe and predict relationships, whereas qualitative research delves into and elucidates those relationships and contextual variations in their nature (Garbarino & Holland, 2009, p. 11).

The researcher employed an exploratory-sequential approach, which is a two-phase method utilized when the researcher intends to complement qualitative findings with quantitative analysis (Creswell, Plano Clark, Gutmann, & Hanson, 2003). This design aims to utilize the results of the initial qualitative method to guide and inform the subsequent quantitative method (Greene et al., 1989). Figure 1 illustrates the phases of the exploratory sequential design.

Figure 1: *A Visual Representation of the Exploratory Sequential Design*



Source. Oven (2016).

This design presented in Figure 1 is based on the premise that exploration is necessary due to various reasons: the unavailability of measures or instruments, unfamiliar variables, or a lack of guiding frameworks or theories. As this design begins with qualitative research, it is most suitable for exploring a phenomenon (Creswell et al., 2003). It also proves beneficial when researchers need to develop and test an instrument in the absence of an existing one (Creswell, 1999; Creswell et al., 2004) or when identifying important variables for subsequent quantitative investigation when the variables are unknown (Edmonds & Kennedy, 2017).

1.11.2. Population and Sampling

a) Population

There were two target populations in this research. The first is all visually impaired students who were enrolled at the El-Oued University during the academic year 2020/2021. They met each other's in the Braille club regularly. They were attending the Braille club regularly.

Conversely, the second population represents all the visually impaired pupils. They learned English as a foreign language at Robbah School for SVI in the third-year middle school over the 2020-2021 school year.

b) Sample

The researcher depended on a random sampling technique where every unit in the population has an identical probability of being selected for the sample, leading the investigator to utilize the stratified random sampling approach. This method involves dividing the population into distinct groups, and the sample is then composed of randomly chosen members from each group. The researcher uses the Taro Yamen formula to measure the number of pieces in this study. This formula uses to determine the size of samples from the target population.

$$n = \frac{N}{1 + Ne^2}$$

The total number of participants of EL-Oued University was six visually impaired students (*n*=6). In comparison, the total number of participants of the 2nd sample at Robbah School for VI pupils was also six students with visual impairment (*n*=6).

1.11.3. Data Gathering Tools

a) Semi-Structured Interview

The qualitative interview is a dominant method used for gathering consistent qualitative data. This type of interview captures rich and descriptive data about a participant's thoughts, beliefs, and knowledge about a topic (Johnson & Christensen, 2019). For this purpose, the interviewer asks the respondents a set of oral questions (Gall, Gall & Borg, 2007). Furthermore, the interview instrument is a way of gaining an in-depth understanding of an interviewee's story.

From this view, phenomenology study mainly uses interviews, in which a researcher highlights the individual participant's lived experience (Seidman, 2006).

The researcher employed a semi-structured interview. It involves open-ended, closed-ended, and probing questions to gain rich information from research participants (Gall, Gall & Borg, 2007). Moreover, it could be possible to make follow-up answers because respondents could immediately clarify ambiguous statements or meaning through additional open-ended questions, i.e., probing questions (Ary, Jacobs & Sorensen, 2010; Gall, Gall & Borg, 2007). Then the validity of reports increased substantially (Gay, Mills & Airasian, 2009).

b) Quasi-Experiment

Reading speed is the measurement of the quantity of words read correctly within a time frame of one minute, typically denoted as words per minute (WPM). Accordingly, reading performance was determined using a reading speed test. There were two phases in this stage: the pre-intervention phase using printed Braille paper and the post-intervention stage using an electronic Braille display. Before starting testing, each participant was trained to use this intervention (an electronic Braille display) to promote accessibility of assistive technology materials. The reading materials used were two short passages measuring each sample's reading rate. The participants were asked to read out loud at a comfortable volume.

- **The Reading Material**

The reading material was a passage used for pretest and post-test measurements. The passage (Appendix Q) was from a collection of reading material on the website of rang-chang.com (retrieved from http://www.rong-chang.com). This website is a free online English teaching and learning material. It contains graded readers from Beginner to Intermediate levels

of English. The total number of text segments was 99 words. The rationale behind choosing this material was that the website provides texts and audio recordings of native English speakers.

- **Experiment Instrument**

In this study, a reading speed test was utilized to measure the speed at which individuals with SVI read English. The measurement of reading speed was expressed in terms of words per minute (WPM).. They were calculated using the three following three steps:

- **The 1st step:** Whole Minutes Read × 60 + Extra Seconds Read = Total Seconds Read.
- **The 2nd step:** Number of Words Read ÷ Total Seconds Read = Words Per Second.
- **The 3rd step:** Words Per Second x 60 = Words Per Minute.

- **Experiment Procedures**
  - **Pretest Phase:** In this phase, students with visual impairment read the given text (Appendix Q) printed on Braille paper (Appendix R).
  - **Post-test Phase:** In this phase, visually impaired students read the same text given in the previous stage (Appendix Q) to swell (increase) lexis identification. The participants used an electronic Braille display as an assistive technology tool for reading (Appendix H).

- **Results Analysis Tests**

The researcher used the paired sample t-test to analyze the test results of two data sets (pretest and post-test) because there was only one group in each sample. This test compares the same group by conducting the test twice. Additionally, the researcher employed the independent samples t-test to compare the means of two independent groups and determine if there is statistical evidence of a significant difference in the associated population means.

1.12. Theoretical Framework

A theoretical framework offers valuable insights into emerging stories derived from analyses, guiding researchers towards unexplored avenues of investigation that might otherwise be overlooked (Sandelowski, 1993). Consequently, by posing questions about a phenomenon, the investigation gains direction through the theoretical framework, while thorough data analysis leads to significant findings (Corbin & Strauss, 2012; Sandelowski, 1993).

Alternatively, the value of a theoretical framework is enhanced by the comprehensive depiction offered by the analysis (Corbin & Strauss, 2012; Sandelowski, 1993). Nonetheless, employing a theoretical framework in qualitative research runs the risk of influencing findings or inhibiting the process of inductive exploration (Corbin & Strauss, 2012; Glaser & Strauss, 1999; Morse, 1992). Recognizing these concerns, the objective is to optimize the usefulness of a theoretical framework while avoiding the imposition of preconceived notions on the data (Corbin & Strauss, 2012).

1.12.1. Rogers' Innovation Diffusion Theory

This study investigates how students with visual impairment implement assistive technology based on their experiences. Hence, the aim is to identify the impact of these innovations' utilization on the TEFL process. For this purpose, the current study adopts Rogers's theory because it considers the various aspects determining adopting an innovation. Therefore, this theory provides a guide for exploring the nature of the potential impact of used AT devices on TEFL for SVI.

Rogers' Innovation Diffusion Theory is a foundational framework for studying the adoption and spread of information technologies (IT) among communities (Rogers, Singhal, & Quinlan, 2014; Venkatesh, Morris, Davis, & Davis, 2003). It is widely used to assess the value of

innovations (Rogers, 2003), with over 6,000 social science studies applying this theory to examine social change processes in this domain (Robinson, 2009).

According to Rogers' Innovation Diffusion Theory, an innovation is defined as an idea, process, or technology that is perceived as new or unfamiliar by individuals within a particular area or social system. The theory emphasizes that the diffusion of innovation takes place as information about the innovation gradually flows from one person to another over a period of time within the social system. Rogers proposed a theory encompassing five key attributes of innovation: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. These attributes play a significant role in determining whether individuals choose to embrace or decline an innovation.

1) Relative Advantage

Rogers (2003) defined relative advantage as “the degree to which an innovation is perceived as being better than the idea it supersedes” (p. 229). In this study, relative advantage depends on the adoption of assistive technology among visually impaired students. In other terms, this attribute relies on whether AT resources enable or enhance learning and teaching processes. However, what defines “better” is, for instance, the idea of relative advantage can be influenced by factors such as improved performance, cost-effectiveness, and an elevated social status (Jacobsen, 1998).

2) Compatibility

Rogers (2003) stated that “the degree to which an innovation is perceived as consistent with the existing value, past experiences, and needs of potential adopters” (Rogers, 2003, p. 240). Incompatible IT innovations can impede usage, while compatible ones reduce uncertainty and increase adoption rates (McKenzie, 2001; Sherry, 1997).

3) Complexity

Rogers (2003) defined complexity as "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 257). He stated that complexity is inversely linked to the adoption rate of an innovation, unlike the other attributes. Therefore, excessive complexity acts as a significant barrier to its adoption.

4) Trialability

According to Rogers (2003), trialability is "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258). Trialability is a factor that influences the speed of adoption. According to Rogers (1995), trying out innovations provides valuable information during the persuasion and implementation stages. Trials allow individuals to test the technology without making a full commitment to purchase or adopt it. This helps to avoid incorrect assumptions about the technology. Additionally, trials offer the opportunity to modify or reinvent the innovation to better suit potential adopters (Jacobsen, 1998).

In light of this, trialability refers to the need to be able to test an AT by visually impaired learners before its complete adoption in their educational settings for learning purposes.

5) Observability

Rogers (2003) defined observability as "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258). Observability, according to Finley (2003), is linked to the rate at which innovation is embraced. In this context, observability refers to the level of visibility associated with the utilization of a particular technology in the presence of others. The act of witnessing, hearing about, or being aware of individuals using a technology significantly influences the likelihood of its adoption. As the number of users of a technology grows, public

awareness regarding its existence also increases. Consequently, the adoption rate rises until the technology becomes commonplace and reaches market saturation (Finley, 2003).

In summary, according to Rogers (2003), the speed of innovation adoption by potential users depends on factors such as the innovation's relative advantage, compatibility, simplicity, trialability, and observability. Rogers acknowledges that introducing a new idea, even with evident advantages, can be difficult. Nevertheless, the presence of these innovation variables facilitates the diffusion process and expedites the adoption of the innovation.

In this study, relative advantage means that visually impaired students choose to use an AT device for a specific task if this tool provides them with outcomes or benefits for the task concerned. The compatibility of an innovation would positively affect AT use. Thus, an adopted assistive technology tool should be integrated into the user's life and practices. Moreover, complexity indicates the sense of difficulty that the visually impaired user has in using and understanding assistive technology tools.

Additionally, trialability refers to the need to be able to test an AT by visually impaired learners before its complete adoption in their educational settings for learning purposes. While visually impaired students may not be able to physically witness the functioning of a new technology, they can still communicate their personal experiences of using it to their peers through spoken or written means, fostering awareness and discussions about the innovation.

1.13. Operational Definitions of Key Terms

Assistive technology (AT) is "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Kelly & Smith, 2011, p. 75).

Braille is a system of raised dots that can be read with the fingers by people who are blind or who have low vision. In this touch reading and writing system, Embossed dots are regularly spaced in quadrangular letter spaces or cells in this touch reading and writing system for the blind. Then, six dots, three high and two wides can be placed in each cell (Braille Authority of North America, 1994, p. 1).

Educational technology is any tool, equipment, or device, whether electronic or mechanical, that assists students in achieving specific educational objectives (Davies, Sprague, & New, 2008).

English as a Foreign Language (EFL) refers to the study of English as an additional language in countries such as Japan, China, or Venezuela, where English is not the primary language spoken by the population (Brown, 2013, p.12).

English as a Second Language (ESL) involves non-native speakers studying English in an English-speaking setting, which could be a country where English is the native language like the United States, Canada, or Australia (Brown, 2013, p.11).

Inclusive education integrates students with disabilities or other special needs alongside non-disabled learners into regular curricula in the same educational environment (Fogarty-Perry & McKenzie, 2020).

Learning disabilities (LD) are "disorders involved in understanding or in using spoken or written language that results in substantial difficulties in listening, speaking, reading, written expression, or mathematics" (Turnbull, Turnbull, Shank, & Leal, 1999, p. 123).

Special education is a "specially designed instruction, at no cost to parents, to meet the unique needs of a child with a disability, including instruction conducted in the classroom, in the home,

in hospitals and institutions, and other settings, and instruction in physical education" (IDEA, 1997, p. 12).

TEFL stands for Teaching English as a Foreign Language for learners whose first language is not English (Huang, 2012).

Visual impairment is "an impairment in vision that, even with correction, adversely affects a child's educational performance. The term includes both partial sight and blindness" (IDEA, 2004).

1.14. Structure of the Thesis

There are five chapters in this thesis:

Chapter 1 presents an introductory chapter that sets the scene for this research. This chapter contains the introduction, background of the study, statement of the problem, research objectives, research questions, hypotheses of the study, the purpose of the study, the significance of the study, research methodology, delimitations of the study, limitations of the study, theoretical framework, operational definitions of the key terms, and the structure of the study.

Chapter 2 includes a comprehensive description of the related literature review of the research topic. This chapter consists of three main sections. Each one addresses a related aspect of the three variables in the context of SVI' education: (a) visually impaired learners, (b) teaching English as a foreign language, and (c) assistive technology. This chapter concludes with previous studies reviewed.

Chapter 3 justifies the methodological design of this research. It explains the methodological decision behind research participants, data collection method, and data analysis procedures. Additionally, this research describes the trustworthiness of data. Besides, this research provides quality assurance and ethical considerations.

Chapter 4 is purposely for a systematic analysis of the results and interpretation of the qualitative and quantitative data parallel to the research questions.

Chapter 5 discusses the findings, limitations of the study, recommendations for future research endeavors, and conclusion.

Chapter Summary

The primary goal of this chapter was to introduce the research topic of the impact of using AT on TEFL for visually impaired students. This chapter elaborated on the context of the study that intends to lay the introductory ground to guide this inquiry. This chapter identified the research problem, research objectives, research questions, hypotheses of the study, and purpose of this study. Additionally, this research anticipated the beneficiaries of this study. Furthermore, the delimitations described the boundaries of the current study and its limitations. This chapter also highlighted the research methodology design and the theoretical basis for this investigation. Moreover, this chapter provided operational definitions of key terms. Finally, this chapter included a guide for the organization of this thesis.

CHAPTER TWO: LITERATURE REVIEW

CHAPTER TWO: LITERATURE REVIEW

Introduction

In this section, the literature aims to contextualize the related concepts of the research problems. It consists of four major sections. The first section provides background information related to understanding the nature of the visual impairment concept. In addition, its influence on the developmental areas of individuals with VI. The second section discusses the education of students with visual impairment in separated (special) and general (inclusive) educational settings.

The third section explains historical practices of teaching a foreign language to SVI and their linguistic characteristics in how they learn a second language. The fourth section concludes with literature that discusses the use of assistive technology for individuals with disabilities, particularly those with visual impairments. In the same vein, this section highlights the significant considerations for effective AT resources and the challenges of their use in education. Moreover, this section provides an overview of the potential/ limitations of some common AT tools for SVI.

2.1. Understanding Disability as a Concept

According to Mitra (2006), there was no unique definition for the concept of disability (p. 236). In a similar view, the World Health Organization (WHO) reported in 2011 that defining disability as a concept "is complicated, complex, dynamic, multidimensional and contested" (WHO & World Bank, 2011, p. 3). Pinilla-Roncancio (2015) considered disability a concept with multiple definitions depending on the perspective or dimensions that play a role in constructing this notion. Because of these views, Mitra (2017) stated that using "a model clarifies

terminology to promote a consistent use" (p.10). Accordingly, the literature provided definitions based on the philosophy underlying models of disability.

2.1.1. Disability Models

2.1.1.1.The Medical Model: Disability as a Disease

According to Mitra (2017), the medical model of disability relates to the individual's health status (wellness or illness). She stated that disability results from "a problem of the individual that is directly caused by a disease, an injury, or some other health conditions and requires medical care in the form of treatment and rehabilitation" (p. 20). Then, this model assumes that disability could be fixed or cured only by addressing the diseases behind health conditions (Al Ju'beh, 2015, p. 20). Hence, the medical model focuses on ensuring health care and the medical services of rehabilitation for individuals with a disability (Goodley, 2016).

Wikman, Marklund, and Alexanderson (2005) stated that diseases are temporary conditions from a medical point of view. The authors illustrated that people are not disabled when their decreased capacity is only a temporary health condition. On the other hand, individuals are disabled when they have a permanent health condition that diminishes their ability. In the context of this model, disability is irreversible (Wikman et al., 2005). For example, disability occurs when a person is blind at birth (a permanent health condition). On the other side, individuals are ill (not disabled) when they cannot see because of severe eye inflammation, as their situation is a temporary health condition (Wikman et al., 2005).

2.1.1.2.The Social Model: Disability as a Socially Constructed Phenomenon

The social model represents a basis for human rights. According to this model, defining the notion of disability relates to a social creation, not the attribute of the individual (Mitra, 2006). In simple terms, disability is a sociological phenomenon, not an individual problem. From

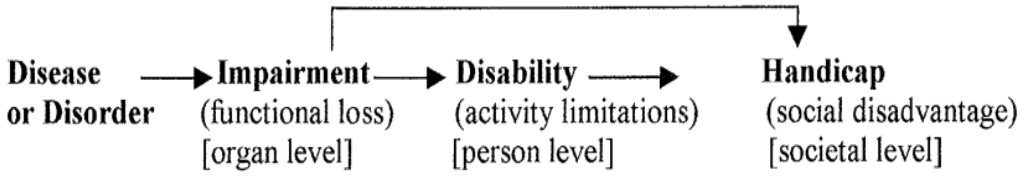
this perspective, disability is socially constructed Medeiros, Diniz, and Squinca (2006). Furthermore, the social model contextualized disability as a part of the social environment. Thus, environmental, institutional, and attitudinal constraints could hinder, deprive, or even exclude individuals with a disability from full participation in society (Mitra, 2006, p. 237).

Consequently, Mitra (2017) explained that "dis-ability" as a term implies negative connotations because the prefix "dis" entails the sense of "absence" or "negation" of the ability (p. 9). For this reason, this model insists on avoiding using the term "disabled" to refer to people who experience disability. One reason is that this term, for some time, reveals stigma. Thus, using the statement "individuals with special needs" or "people with disability" are alternatives to highlight the person's importance rather than the disability. However, the social model focuses on individual empowerment. It neglected the influence of personal limitations on disability like self-esteem or motivation (Al Ju'beh, 2015, pp. 83-86).

2.1.1.3.The ICIDH Model

In 1980, the WHO developed the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) model to define disability as a concept. This model represents a synthesis framework of the medical and social models. The ICIDH provided a conceptual scheme that explains the relationship between the terms "impairment," "disability," and "handicap" (Johnston & Pollard, 2001). To illustrate how this model works, Figure 2 below consists of a linear sequence of Disease → Impairment → Disability → Handicap to describe the conditions deriving from the disease (Farias & Buchalla, 2005).

Figure 2: *A Scheme of the ICIDH Model of WHO 1980*



Source. Johnston and Pollard (2001, p. 1261).

According to the WHO (1980), impairment is "any loss or abnormality of a psychological, physiological, or anatomical structure or function" (p. 27). In the ICIDH model, an "impairment" could occur at the level of system function or organ (s) that would result from known or unknown diseases or disorders (Schuntermann, 1996). Consequently, impairment of body functions causes disability. Accordingly, disability links to "any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being" (WHO, 1980, p. 28).

The ICIDH model clarified that a disability due to functional performance limitation could affect or restrict a person's ability (Johnston & Pollard, 2001). Furthermore, a handicap is "a disadvantage for a given individual, resulting from an impairment or a disability that limits or prevents the fulfillment of a normal role for that individual" (WHO, 1980, p. 182). Thus, a handicap indicates those consequences that place individuals at a disadvantage compared with their peers.

2.1.2. Classifications of Disability

"Classification is the process of forming groups from a large set of entities based on their similarities and dissimilarities" (Fletcher et al., 2002, p. 1). For children aged 3 through 21 years old, the IDEA identifies thirteen disability groups, typically grouped into two categories, high- and low-incidence disabilities. The high-incidence category includes specific learning

disabilities, intellectual disabilities, multiple disabilities, speech or language, orthopedic, emotional, and other health impairments. The low-incidence category includes autism, traumatic brain injury, hearing impairment, deafness, visual impairment (including blindness), and deaf-blindness (Bartz, Kurth, & Wangeman, 2015).

2.2.2.1.Classifications Based on the Type of Disability

In their book *Meeting the Needs of Children with Disabilities*, Laudan Aron and Pamela Loprest (2007) provided a classification of the prominent disability types (pp. 23-25).

a) Congenital Disabilities

Congenital disabilities are a set of conditions at birth or soon after birth. This type may or may not result from genetic factors such as cerebral palsy (Aron & Loprest, 2007, p. 23). The World Health Organization defined congenital disorders as "any potential pathological conditions arising before birth, whether evident at birth or manifesting later in life" (WHO, 2000; WHO, 2005; WHO, 2006).

b) Acquired Disabilities

The term "acquired disabilities" refers to some disabilities that result from a disease or accident. For example, an organ amputation due to a car accident injury is (p. 23).

- **Physical Disabilities:** Physical disabilities are somatic conditions that significantly affect significant life activities. This type may be congenital or acquired (p. 24).
- **Sensory Disabilities:** Generally, sensory disability refers to visual or hearing impairments. Subgroups may include blindness, deafness, and deaf-blindness (p. 24).
- **Cognitive Disability:** Cognitive disabilities refer to the brain's inability to process, retrieve, or restore information. For example, learning disabilities such as reading, writing, or mathematics are cognitive disabilities (Aron & Loprest, 2007, p. 24).

- **Mental Health and Psychiatric Disabilities:** "Mental illness" and "Psychiatric illness" involve a broad spectrum of psychiatric disorders. Some of the most common forms of mental disabilities are the loss of thinking, remembering, and reasoning skills (Alzheimer's disease), and depressive disorders (bipolar mood disorder) (Aron & Loprest, 2007, p. 25).
- **Speech and Language Disabilities:** Disabilities at the levels of speech and language are a set of disorders in communication. These may include an inability to understand, involuntary repetitions and prolongations of speech (stuttering disorders), or difficulties with pronunciation. Some causes of these disabilities may go back to neurological disorders such as mental retardation. However, frequently, it is hard to diagnose the actual cause (Aron & Loprest, 2007, p. 25).

2.2.2.2.Classification Based on the Restriction Levels of Disability

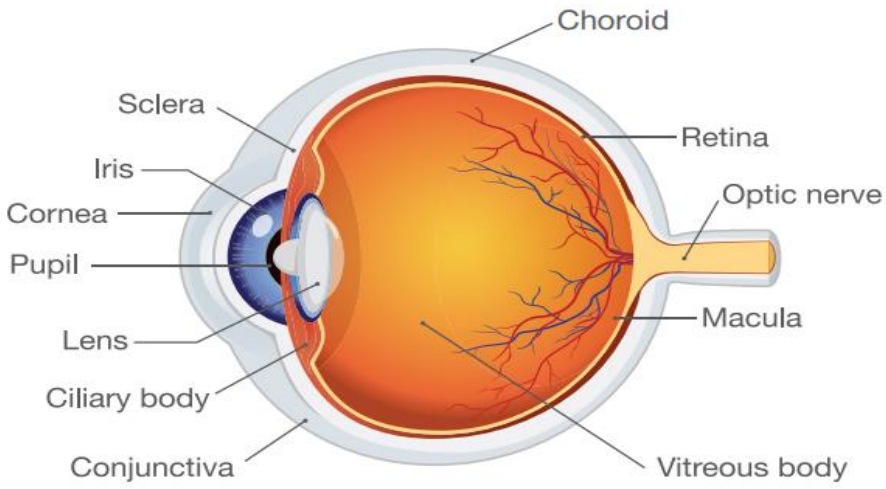
According to Boat and Wu (2015), disability has four levels of restriction:

- **Mild:** It occurs when an individual has no difficulties performing a core activity independently with minimum support grades (Boat & Wu, 2015, p. 171).
- **Moderate:** This level occurs when a person with a disability has difficulties performing an activity in daily situations. Then, this limited support requires someone's help (p. 171).
- **Severe:** This level of restriction requires daily assistance with a high degree of self-care activities and safety supervision. Hence, people with severe disabilities need extensive support for achieving their daily activities (p. 171).
- **Profound:** this level is the highest degree of disability, where a person requires pervasive support for any aspect of daily life routines (p. 171).

2.1.3. Understanding Visual Impairment as a Concept

The human visual system enables the vision functions to support a variety of tasks. The visual system includes the eyes, optic nerves, and pathways to and from various brain areas (WHO, 2019, p. 5). Figure 3 below illustrates the parts of eye anatomy.

Figure 3: *The Parts of Eye Anatomy*



Source. National Center for Children's Vision and Eye Health (n. d).

The cornea and lens, at the front of the eye, focus light entering the eye onto the retina. Light is transformed into nerve impulses in the retina, which travel through the optic nerves and pathways to the brain's visual cortex. These impulses are subsequently transported to many different areas of the brain, where they combine with other inputs (such as hearing or memory) to allow a person to understand and respond to their surroundings (Kaas & Balaram, 2014; WHO, 2019).

In their study, Praat and Keil (2003) agreed that the term "visual impairment" has no universally accepted definition worldwide. The researchers stated, "there is no standard definition and related assessment tool that could be used across research contexts" (2003, p. 40). Accordingly, they agreed that the terminological inconsistency is related to the criteria determining the visual system's eligibility (Praat & Keil, 2003). Nevertheless, the most used

definition is originally a part of the World Health Organization (WHO) legislation. Consequently, any definition could be acceptable if it matches this legislation (Praat & Keil, 2003).

2.1.3.1.Legal-Based Definition for Visual impairment

In the World Report on Vision in 2019, the ICFDH described "impairment" due to a known or unknown health condition. Impairment results in diseases or disorders in the body's functions or structures (WHO, 2019). From this view, "a vision impairment results when an eye condition affects the visual system and one or more of its vision functions" (WHO, 2019, p. 10). Thus, visual impairment refers to any degree of vision loss because of an abnormality of the optical system that affects a person's visual ability (WHO, 2019).

The current research adopted the Individuals with Disabilities Education Act (IDEA) definition of the "visual impairment" concept of 1997. The IDEA is the special education law in the United States of America. The core substantive right of this law was that every child with a disability should receive "a free appropriate public education in the least restrictive environment" (Aron & Loprest, p. 28). The IDEA of 1997 is officially defined as "an impairment in vision that, even with correction, adversely affects a child's educational performance. The term includes both partial sight and blindness" (IDEA, 2004).

2.1.3.2. Sight Measurements

Referring to the WHO and World Bank (2011), visual impairment generally relates to the "best-corrected" vision. This latter refers to using the best-possible refractive corrections, such as eyeglasses, contact lenses, or surgery, to assess the extent of visual impairment (Resnikoff, Pascolini, Mariotti, & Pokharel). From a medical perspective, this process "aims to confirm the

impairment, establish the diagnosis, identify the treatment required and describe the prognosis for the disorder(s) causing visual loss" (WHO & World Bank, 2011, p. 11).

Accordingly, the best-possible vision measurement includes, but is not limited to, two main clinical assessment examinations: visual acuity and visual field tests. The former is to measure the clarity of vision. The latter eye examination estimates the degree of the field of vision and then the visual field defects of either one or both eyes (Holz et al., 2013).

a) Visual Acuity Test

The term "visual acuity" (VA) refers to the obtained score of an eye examination test that detects the degree of vision loss and the potential for any specific rehabilitation (Cline, Hofstetter, & Griffin, 1997). This test records the value of the "best-corrected" vision of the examinee's better eye. In other words, this test's result represents the maximum visual acuity in the better-seeing eye (Walker, Hall, & Hurst, 1990).

For this purpose, the eye examiner conventionally measures the score of VA by the Snellen Scale test. Snellen's chart consists of a picture of a big black "E" with a set of numbers and random letters arranged in decreasing sizes (Ormerod & Mussat, 2006). A typical Snellen chart uses a ratio of "20-foot" (6 meters) as a standard distance to measure visual acuity. The Snellen fraction of "20/20" technically expresses the familiar value representing the "normal" visual acuity (Appendix A).

The typical distance in the American United States is 20 feet, whereas it is 6 meters in the United Kingdom (Marsden, 2008). The first number refers to the obtained distance of the examinee's ability to recognize symbols of the Snellen chart with correction instruments. On the other hand, the second number indicates what a "normal" eye can see these symbols at a given distance (Evans, 2006; Ormerod & Mussat, 2006).

b) Visual Field Test

The field of vision (VF) refers to the entire area of how far one's eye can see objects in any direction when both eyes focus on a single point (Heller, Calcaterra, Burson, & Tyler, 1996; Hardman, Drew, & Egan, 2005). The VF test includes, but is not limited to, Donder's test. A patient covers one eye and stares at the examiner in this test. To test the limits of VF, the clinical therapist intentionally moves one hand out of the examinee's visual field and then brings it back into the field of vision. Then, the eye examiner determines the extent of the patient's VI based on the potential of both eyes (Brilliant, 1999). This test measures an examinee's left and right eye's central and peripheral visual fields (Geddie, Bina, & Miller, 2013).

A typical visual field of a fully able human eye extends to approximately 60 degrees (60°) nasally, 100 degrees (100°) away from the nose, 60 degrees (60°) upward, and 75 degrees (75°) downward (Spector, 1990). Traditionally, visual acuity loss to 20/200 has been considered equally disabling as a visual field loss to a 10° radius. The ICD-9 defines *Severe*, *Profound,* and *Near-total* visual field loss as the concentric restriction to a 10° to 5° and 2.5° field radius. Therefore, the visual field Score is a reasonable estimate of the field-related visual abilities. An individual's visual field is the second critical variable in assessing functional vision and diagnosing visual impairment (Colenbrander, 2005).

***2.1.3.3.*Vision Impairment Types**

In October 2006, the WHO released two general categories of visual impairment based on the 10th revision of the International Classification of Diseases (ICD-10) (WHO, 2006). In this classification, sight defects included two categories: (1) Low Vision and (2) Blindness. Understanding these two medical terminologies are primarily related to the score of the "best-

corrected" visual acuity. The obtained value represents one's eye capability to see clearly at a specific distance using corrective instruments such as glasses (Dandona & Dandona, 2006).

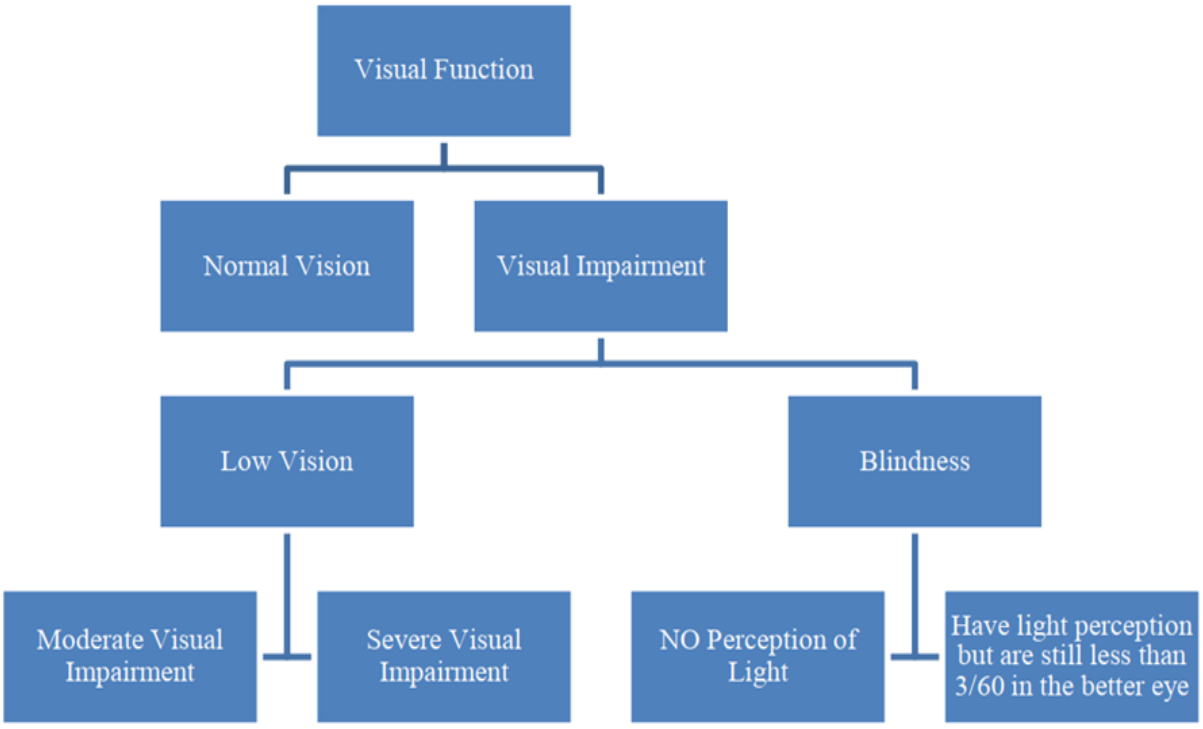
- **Low Vision:** From a medical perspective, low vision occurs when a person has a visual acuity of less than 6/18 to light perception or a visual field of less than 10° from the point of fixation with regular glasses or contact lenses (WHO, 2008, p. 1; WHO, 1993). Similarly, Corn and Lusk (2010) agreed that individuals with low vision face difficulties accomplishing visual tasks even when using the best possible corrective lenses. Nevertheless, persons with low vision can enhance their ability to perform these tasks using compensatory optical devices, strategies, and environmental accommodations (Corn & Lusk, 2010, pp. 4-5).
- **Blindness:** On the other hand, blindness occurs when an individual's best eye has a visual acuity of 20/200 or worse in the better eye or no more than 20° of the visual field. However, the current definition of blindness does not give a clear distinction between individuals who have "irreversible" blindness (NO perception of light) and those who have light perception with a visual acuity of less than 3/60 in the better eye (WHO, 2008, p. 2). Light perception only refers to individuals without sight but can distinguish between the presence and absence of light (Heller, Calcaterra, Burson, & Tyler,1996).

Interestingly, common stereotypical assumptions reveal that blind people or low vision live in a "blackness" that sighted people see when they close their eyes. Blindness is not always a total absence of visual sensations. However, only a small percentage of blind people are completely blind, while most can 'see' some sort of light or sense the direction of that light (Dunlea, 1989; Duffy et al., 2019).

2.1.3.4. Visual Impairment Severity

Furthermore, The International Classification of Diseases (ICD-10) distinguished four levels of visual acuity in the best eye: (1) mild or no visual impairment, (2) moderate visual impairment, (3) severe, and (4) blindness. Low vision includes two severity levels: moderate visual impairment and severe visual impairment. On the other hand, blindness has three levels: (a) VI persons have a visual acuity of 3/60 but cannot count fingers at 1 meter. (b) a VI individual "have light perception, but are still less than 3/60 in the better eye". (c) "irreversible" blindness where a person with VI has " No Perception of Light" (Abd El-Maksoud, Gharib, & Hussein, 2016; Dandona & Dandona, 2006; WHO, 2014). Figure 4 clarifies the classifications related to visual function.

Figure 4*: Classifications of Visual Functions Based on the WHO Classifications of 2014*



Source. World Health Organization (2014).

Figure 4 summarizes the categories of visual impairment defined in the WHO's International Classification of Diseases (ICD-10) based on presenting distance visual acuity in the better eye.

Table 1: *Categories of Visual Impairment Severity Levels*

	Presenting distance visual acuity	
Category	Worse than	Equal to or better than
Mild or no visual impairment 0		6/18 3/10 (0.3) 20/70
Moderate visual impairment 1	6/18 3/10 (0.3) 20/70	6/60 1/10 (0.1) 20/200
Severe visual impairment 2	6/60 1/10 (0.1) 20/200	3/60 1/20 (0.05) 20/400
Blindness 3	3/60 1/20 (0.05) 20/400	1/60* 1/50 (0.02) 5/300 (20/1200)
Blindness 4	1/60* 1/50 (0.02) 5/300 (20/1200)	Light perception
Blindness 5	No light perception	
9	Undetermined or unspecified	

Note. Counts fingers (CF) at 1 meter. 6 meters = 20 feet (6/6 = 20/20).

Source. (Baxter, Wormald, Musa, & Patel, 2014, p. 2).

Table 1 classified categories of visual impairment from 0 to 5. First, category 0 represents "mild" or "no visual impairment." Second, visual impairment in categories 1 and 2 refers to "moderate" and "severe" visual impairment combined under the term "low vision." Finally, categories 3, 4, and 5 refer to "blindness." In addition, category 5 indicates "no light perception." Furthermore, category 9 includes undetermined causes behind visual impairment (Nuertey et al., 2019, p. 2).

2.1.4. Prevalence of Vision Loss

2.1.4.1.Prevalence Associated with Visual Impairment Causes

The potential of the human visual system is remarkable due to the intelligent design of the optical system. However, a wide variety of eye diseases yields a reduction in the performance of the optical system (Navarro, 2009). The global statistics of WHO in 2010 show that the estimated number of individuals with visual impairments is 285 million worldwide. There were 246 million persons with low vision and 39 million with blindness. These statistics rely on fifty-three surveys from 39 countries. Most of the studies (38) took place between 2005 and 2008, whereas 15 were between 2001 and 2004. (Pascolini & Mariotti, 2012, p. 615).

The WHO (2010) estimated cataracts, glaucoma, refractive errors, age-related macular degeneration, and retina defects are the most frequent eye diseases or disorders (Appendix B) (Pascolini & Mariotti, 2012). For example, Figure 5 illustrates a simulation of the visual impairment levels resulting from four common eye diseases (Manduchi & Kurniawan, 2018). Figure 5 provides images that try to simulate these conditions.

Figure 5: *Simulations of Normal Vision Compared to Common Five Eye Diseases*

Source. (Manduchi & Kurniawan, 2018, p. 19).

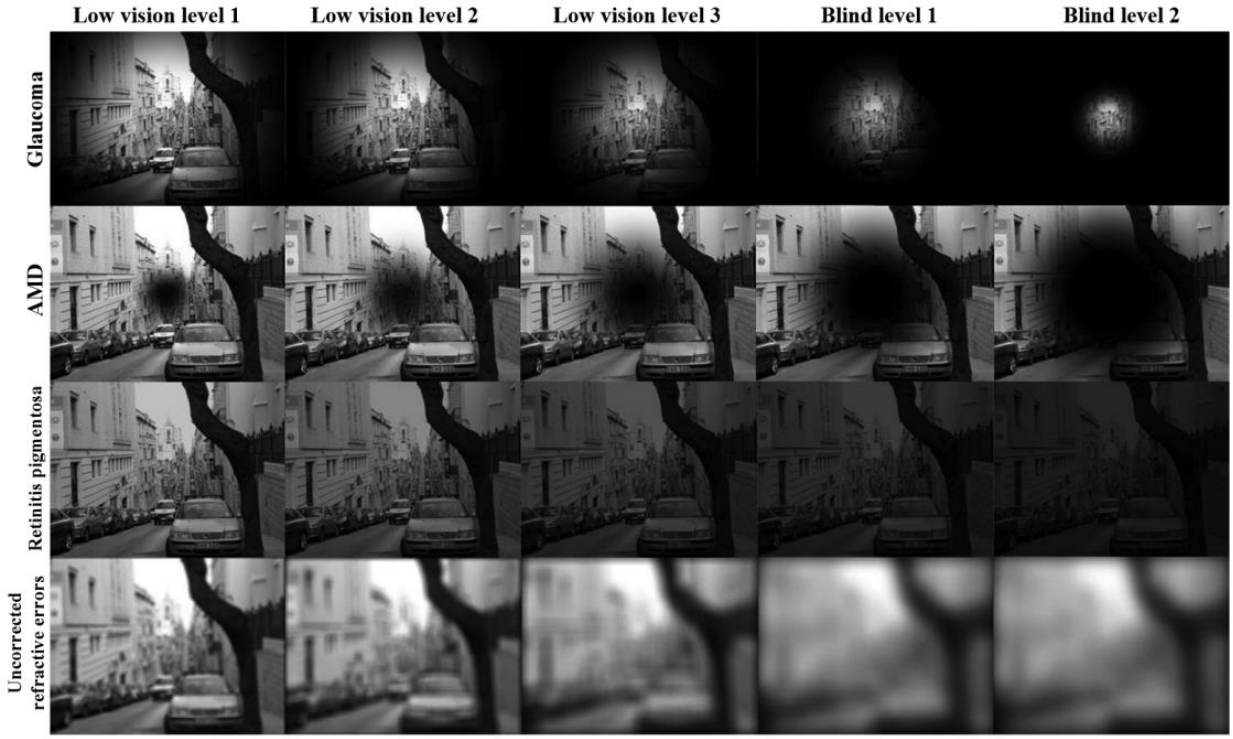
According to the WHO estimates in 2010, the leading causes of visual impairment resulted in 42% for “uncorrected refractive errors,” 33% for “cataracts,” and followed by 18% for “undetermined causes.” Furthermore, other reasons behind VI linked to 2% for “glaucoma” and 1% for “age-related macular degeneration” (AMD), “diabetic retinopathy,” “corneal opacities,” and “trachoma.” On the other hand, cataracts by 51% and glaucoma at 8% were the leading causes of blindness (Pascolini & Mariotti, 2012, p. 616).

2.1.4.2.Prevalence Associated with the Visual Impairment Severity

According to the latest World report on vision released by the World Health Organization (WHO) in October 2019, at least 2.2 billion people had vision impairment or blindness, of which over 1 billion cases could have been prevented or have yet to be addressed (WHO, 2019, p, 27).

Under the WHO estimates in 2019, the statistics revealed that 88.4 million people had unaddressed refractive errors. In addition, 94 million visually impaired persons were due to cataracts. On the other side, 7.7 million visually impaired individuals had glaucoma. Furthermore, 4.2 million VI were a result of corneal opacities. Besides, 3.9 million had diabetic retinopathy. There were 2 million because of trachoma. At the same time, around 826 million vision impairment cases were because of unaddressed presbyopia (Steinmetz et al., 2021). Figure 6 shows the common eye diseases based on the degrees of vision loss (low vision and blindness).

Figure 6: *An Illustration of Visual Impairment Levels Based on Common Eye Diseases*



Source. (Hu, Chen, Zhai, Gao, & Fan, 2019, p. 582).

2.2. A Historical Perspective on Education for Visually Impaired Students

Historically, education for visually impaired students started at the close of the 18th century (Jedynak, 2015; Hatlen, 2000; Phillips, 2004). The Institute of Blind Youths School in Paris (France) in 1784 was the first specialist facility in the educational placement for teaching and learning visually impaired learners. Before this date, the negative attitude toward students with visual deficits categorized them as a "part of the indigent poor at large" (Philips, 2004, p. 1).

However, Lowenfeld (1973) identified the right of schooling for VI learners from the educational, psychological, and social aspects. Accordingly, he adopted the social model of disability, in which the social environment plays a vital role in meeting the special educational

needs of learners with disabilities. In his book, *The Visually Handicapped Child in School*, Lowenfeld (1973) called for the right to education for visually impaired students (VIS). This right could provide them with knowledge of the realities around them, confidence to cope with them, and the feelings of being accepted as individuals in their own right (Lowenfeld, 1973, p. 158).

Along with Lowenfeld's view, numerous international legislation insisted on the principle of equal rights for "all" learners, including those with disabilities. Such international legislation, according to UNICEF (2007), included:

- The Universal Declaration of Human Rights (UDHR) in 1948.
- The UNESCO Convention against Discrimination in Education in 1960.
- The United Nations Convention on the Rights of the Child (UNCRC) in 1989.
- The Convention on the Rights of Persons with Disabilities (CRPD) in 2006 (UNICEF, 2007).

These international documents have recognized the right to equality in education for "all" learners, no matter their social background or their health condition, in which Education for All (EFA) can be achieved (as cited in Jedynak, 2015, p. 39). Similarly, Lowenfeld (1956) distinguished the trend toward education for individuals with a visual deficiency from three different perspectives.

The first view implied that SVI could not survive by themselves. Hence, they cannot effectively achieve any educational goals by themselves. This view is behind the need to constitute a special (segregated) education setting for teaching and learning VI learners (Lowenfeld, 1956, pp. 53-90). The second view adopted the right of respected life for individuals with visual problems. The third perspective attempted to integrate SVI into their environments,

including the educational background, and then give them the opportunity for equal education in a regular mainstream, where VI learners learn side by side with their sighted counterparts (Lowenfeld, 1956, pp. 53-90).

Although integrating SVI into inclusive educational settings has become a trend in the last few years, special education is still the first choice in many regions (Higgins & Ballard, 1999). The Nordic countries developed integration in the 1960s. A decade later, both the US and UK followed Nordic countries in implementing the integration of VI learners in inclusive education (Walton, 2006:14). Table 2 shows the major educational events for students with a visual impairment education. It started in 1784 in France, where VI learners studied at segregated or residential schools in 1989, in Greece, where VIS gained the right to equality for education alongside their sighted peers.

Table 2: *Timeline of the Significant Phases of Education for the Visually Impaired Students*

The trends of education for VI learners	Time	Place	Event
Segregated or special schools	1784	Paris	The first school for blind people was established in the world (Lowenfeld, 1956).
	1790	England	The first school for the blind in England (Taylor, & Taylor, 1960).
	1793	Scotland	The first school for the blind in Scotland (Taylor& Taylor, 1960).
	1893	Britain	French (2007) Britain issued the Elementary Education (Blind and Deaf Children) Act to guarantee compulsory education for blind and deaf children (French, 2007).
	1900	Chicago	The first Braille class in a public school was set up in Chicago (Lowenfeld, 1956).

Continued

The trends of education for VI learners	Time	Place	Event
	The 1900s	Britain	Education was provided to blind pupils with extra-special educational needs or impairments and segregated institutions (French, 2007).
	1960	Western Europe	14 Western European Countries provided compulsory education to blind children (Higgins & Ballard, 1999).
	1980	Hungary	A kindergarten department has opened to receive visually impaired or blind children (Kovács, 2002).

Source. Zheng (2014, p. 10)

2.2.1. Special Education and Inclusive Education

According to Lupton and Jones (2002), "special education" and "inclusive education" were two main types of the practice of educating students with visual impairment (SVI). According to the Individuals with Disabilities Education Act of 1997 (IDEA), special education is a "specially designed instruction, at no cost to parents, to meet the unique needs of a child with a disability, including instruction conducted in the classroom, in the home, in hospitals and institutions, and other settings, and instruction in physical education" (IDEA, 1997, p. 12).

In contrast, inclusive education indicates that all learners, including those with disabilities, need to be placed into "age-appropriate" regular classes within one general (public) educational setting (Alquraini & Gut, 2012; Bui, Quirk, Almazan, & Valenti, 2010). Therefore, the aim is to provide learners with special educational needs (SEN) the right to education and offer new opportunities to best achieve their potential. (Lupton & Jones, 2002, p. 1).

For example, a special (segregated) school is a residential institution exclusively where SVI learn with their peers who have disabilities. On the other hand, an inclusive school is a non-

residential educational setting. In this case, visually impaired learners learn with non-disabled counterparts in which the curriculum could contain little or no modification (Pandey, 2018).

2.2.1.1.Educational Placement Criteria for Students with Visual Impairments

According to Kovács (2000), the educational placement for SVI backs to three significant factors that govern the existence of VI learners in segregated or regular educational institutions. The first factor was the traditional attitude to integrate SVI into segregated schools. This view was a choice out of no choice, in which students can only be educated at special schools (Kovács, 2000). Besides, special education often presents the ideal solution for teaching VI learners in many countries (Hodkinson & Vickerman, 2009).

Second, the parent's negative attitude was another reason behind the educational placement for SVI. This factor could determine whether a VI learner should study in special or regular schools (Kovács, 2000). Parents of SEN learners may regard the lack of the necessary provision and support of the schooling system could lead to the failure of their children. Higgins and Ballard (1999) explained that the failure integration of SVI into regular schools is "because blind children are simply not receiving the support they need when attending the regular school" (p.72). Therefore, Thus, within a few years, VI learners may go back to special education school (Marek, 2000).

Nevertheless, Rani (2011) compared the academic achievement of VIS in integrated and segregated school settings. The author concluded that visually impaired learners who are placed in integrated schools performed significantly better than their VI counterparts in segregated schools. The problem with some studies' results was that they compared learners of the same age but did not have the same environment and education conditions. Thus, this comparison led to different results (Rani, 2011).

Third, Vickerman (2009) considered that one reason behind the choice of special education is that VI learners often feel that they are being treated differently than their sight peers at regular schools. This situation forces them to study in segregated schools to feel Habulezi, Molao, Mphuting, and Kebotlositswe (2016) explained that education for SVI into inclusive or special education should not be a matter of a "yes" or "no" question. Hence, the core of the debate should not focus on which educational setting is better than the other. Instead, educators need to identify the educational needs of their VI learners and how to address these needs (Wang, 2009).

2.2.2. Challenges Associated with Visual Impairments

Visually impaired (VI) individuals experience various challenges that affect their quality of life at different levels. A literature review related to VI reveals critical influence (s) on significant developmental areas. These effects include, but are not limited to, physical, cognitive, linguistic, social, and learning development. The more severe visual impairment, the more VI people experience difficulties with these developmental areas (Baillargeon, 1993; Bergwerk, 2011; Brodsky, 2010; Fazzi et al., 1999; Houwen, Schut, van den Bout, Stroebe, & Stroebe, 2010; Pérez-Pereira & Conti-Ramsden, 2019).

a) Physical Development

Visual impairment results from functional limitations in the physical development of the optical system (visual system). Such impairments could hinder the process of motor skills learning. In other terms, VI people experience difficulties with mobility and orientation to different environmental contexts (Bergwerk, 2011; Brodsky, 2010; Frailberg, 1977; Hyvarinen, 2000). Moreover, infants and toddlers with visual limitations could have significant timidity, especially in new environments. Furthermore, they register delayed self-initiated mobility,

balance, and posture while learning many motor skills via modeling. Accordingly, enhancing motor skills for individuals with visual deficits is essential for physical development (Brodsky, 2010; Hyvarinen, 2000).

b) Cognitive Development

In cognitive development, VI persons often have a retarded development of spatial knowledge (Baillargeon, 1993; Hyvarinen, 2000). VI children develop their understanding of space and object around them during their childhood. They form their perception while manipulating different objects using their hands and then test the influence of these movements. Then, the authors recommended that early learning of spatial concepts is a significant step to avoiding or decreasing the delayed development of cognition. Therefore, (Maüešiü-Petroviü, Jablan, Vuþiniü & Eškiroviü, 2005) concludes that difficulties with cognitive development result from limitations in the visual tactile-kinesthetic experience. This factor results in limitations in forming concepts (Maüešiü-Petroviü et al., 2005).

c) Linguistic Development

At the level of linguistic development, visual impairment can disrupt or even delay the language development of visually impaired individuals (Brodsky, 2010; Perez-Pereira and Conti-Ramsden, 1999). For instance, the preverbal and nonverbal communication phase relates to two steps. The first depends on observation, while the second concerns imitating others' lips movement, heads, and hands. This variation in language development between blind and sighted children may result from a diminution of experience or differences in linguistic input (Andersen, Dunlea, & Kekelis, 1993). In light of this, Landau (1983) concluded: "Where relevant experience is lacking, concepts cannot develop; and where concepts are lacking, word meanings cannot be learned" (p. 63).

d) Social Skills Development

Visual limitations can negatively affect attachment, bonding, and social interaction with non-visually impaired individuals (Brodsky, 2010; Hyvarinen, 2000). These challenges are due to the importance of eye contact to develop social interaction as a primary communication skill. In a study, researchers noticed how using eyeglasses affects visually impaired infants. The results show that they immediately express surprise, followed by a smile with eye contact. However, this reveals that VI infants delay development in social interaction. Then, medical support can enhance social communication (Schwartz, Hyvarinen, & Appleby, 1997).

e) Learning Development

In an educational context, impairment in vision significantly affects students' learning process. The situation could be due to the "lack of visual input compromises the ability to see a whole picture or concept as a starting point to learning" (Fast, 2019, p. 5). Consequently, VI learners experience different learning difficulties (Supalo et al., 2006). For example, a sighted child can look at a video, book, or picture to comprehend an elephant's concept, shape, and size. However, a visually impaired child cannot experience the notion of the elephant as a "whole" view (Fast, 2019).

Nevertheless, the early detection of such learning challenges and providing VISs with the appropriate interventions are essential for maximizing their full potential in the learning process (Mills, 1999; Oldham & Steiner, 2010). For this reason, creating an accessible learning environment using adapting instructional materials such as assistive technology may increase the educational achievement of SVI (Friend, 2011).

2.2.3. Language Acquisition and Learning

Language is a rule-based system of written and oral signs (Dussias & Cramer Scaltz, 2008). According to Verderber (1999, p. 52), people of the same community, geographical area, or cultural tradition use language for communicating. Thus, this system is "required for effective interactions and yields a better understanding of one's language and culture" (Moeller & Catalano, 2015, p. 327).

While native speakers have unconscious knowledge of their mother tongue, they know how language should be used early in learning a second language. However, knowing a specific language's words and grammar rules is not enough to learn it. One reason is that language, in a sense, is a cultural phenomenon between social groups. Then, it is necessary to be aware of the cultural aspects of language (Zascerinska, 2010).

In line with this view, Harmer (2001) clarified the difference between the notions of "acquisition" and "learning." On the one hand, acquisition is a long-term subconscious process that results in the knowledge of a language; learning, on the other hand, is a short-term process that results in "knowing about" the language (Harmer, 2001, p. 33).

In his book *Principles and practice in second language learning and acquisition,* Krashen (1982) assumed that knowledge of a second language (SL) is developed in "two distinct and independent ways" (1982, p.10). "Acquisition' facilitates fluency and is a "subconscious process" (1982, p.10) whereby the learner 'picks up' the language in a natural, informal and implicit way.

On the other hand, learning is a conscious process, with learners aware of the rules and formal knowledge of a language. This 'explicit learning' can be used only for 'monitoring' and does not contribute to language fluency. Krashen (1982) did not consider that there is an

interface between these two ways of developing SL knowledge, as “language cannot ‘become’ acquisition” (Brown, 2000, p.278).

2.2.3.1.Effect of Visual Impairment on Linguistic Development

According to Smith (2008), around 80% of the information is gained through sight sense. In a similar view, Bishop (1996, p. 45) explained that people discover their environment predominantly through their eyes. From this perspective, Downing and Chen (2003, p. 56) stated that vision is the most important sense for learning. Then, Human (2010, p. 54) and Zulch-Knouwds (2010, p. 43) considered that visual system function impairment results in learning barriers. Hence, vision loss results in losing information from the surroundings.

In this context, vision could profoundly affect the acquisition and use of language (Warren, 1994). One reason is that sight sense is often the “underlying mechanism that guides the process of language acquisition” (Dunlea, 1989, p. 4). Accordingly, vision enables individuals to maintain a coherent concept of their surroundings and simultaneously grasp large amounts of information. Thus, most, or at least the most reliable, information they acquire depends on their tactual and auditory experiences to form their conceptions about the world (Bigelow, 2005, p. 10).

Studies in developmental psychology confirm that children who are blind from birth or early age acquire language slower than their sighted peers do. For example, Landau and Gleitman (1985) report that blind infants start uttering their first words at 23 and 26 months, whereas Norris et al. (1957) at 15 months, two words at 18, and five words at 24 months. They added that the norm for a sighted child is approximately 10 or 11 months.

Guinan (1997) and Warren (1994) stated that “the meaning of words for sighted children is richer and more elaborate than the meaning for children with visual impairments. Thus, vision

allows children to generalize and broaden semantic associations" (as cited in Morúa Álvarez, 2019, p.30). Perez-Pereira and Conti-Ramsden (1999) debunk the conviction that blind children cannot produce overextensions of concepts. The blind children's opportunities to generalize words are restricted due to limited hands-on experience. The lack of overextension in blind children's language is not an index of impairment but a sign of few possibilities to explore the environment.

The delay in the language development of VI persons is due to the restricted context of non-verbal communication (Andersen, Dunlea, & Kekelis, 1993). In this context, "many arguments assert that language development builds on non-verbal communication (for example, Bates, Camaioni, & Volterra, 1975; Bruner, 1977) and that language development depends on accessing the meaning of sentences from the observable nonlinguistic context" (Hoff, 2001, p. 339). Therefore, the restriction of non-verbal communication affects development concepts.

a) Phonology Level

Unfortunately, an affected phonology development of VI children is not always an unavoidable impact of visual impairment. In turn, this reason may cause language onset delay. In this light, Hoff (2001) noticed that blind children, to some extent, have a slower phonological acquisition. Consequently, they tend to make more errors than sighted children. For example, visually impaired children experience challenges producing speech sounds that rely highly on visible articulatory movements, such as the sounds of /b/, /m/, and /f/ (Hoff, 2001).

However, there is no significant difference between VI children and their sighted peers in producing speech sounds by non-visible articulatory movements. For instance, speech sounds are /t/, /k/, and /h/. This result reveals that visual articulation is a significant aspect contributing to phonological development (Hoff, 2001, p. 339).

b) Lexis Level

The lexical level pertains to the stored mental representations of familiar words and morphemes. It encompasses an understanding of the rules and patterns that dictate the usage and placement of letters in spelling (Apel, Henbest, & Masterson, 2019). The lexicon of blind and sighted children is influenced by their typical experiences, such as having a greater knowledge of terms for household items. Additionally, blind children tend not to generalize a word to represent a category of objects, opting instead to use a single word for a specific thing (Mills, 1993).

When considering an alternative approach to learning, the impact of experience on the formation of the mental lexicon becomes evident. Language acquisition relies on limited and often insufficient experiences, yet remarkably, we consistently acquire language despite encountering only a small portion of possible instances. This raises intriguing questions about the process of language learning (Landau & Gleitman, 1985, p. 2).

The phenomenon of knowledge gaps in blind children has been extensively explored by psychologists, and it has been a topic of significant discussion in the papers of Brambring (2007), Marek (2000), and Walthes (2007). However, relying solely on verbal accounts from others may not provide a complete or clear understanding. The gaps in the lexicon of blind children are evident in their questions, such as "What is the taste of mould?" or "How does one write in an exercise book if it's a type of book?" (Marek, 2000).

c) Syntax Level

In their study, Landau and Gleitman (1985) conducted a study on three children with visual deficiency (n=03). The researchers noted that all three children had a considerable syntax delay. Thus, the researchers concluded that the most meaningful difference is the acquisition of auxiliary verbs in English. The scholars suggest that the mother’s language input is the principal

cause behind syntax delay because maternal speech consists mainly of direct imperative forms. Despite this delay, there is no perpetual harm to speakers of English as a first language (Landau & Gleitman, 1985).

d) Semantics

According to Carney, Engbretson, Sheppard, and Scammell (2003), "development of concepts is the basis of all learning. Spatial relationships, time, body awareness, and self-awareness are just a few examples of fundamental concepts individuals need to make sense of their world" (p. 6). In turn, the limitation of concept development results in gaps in the VI children's knowledge.

Marek (1999) discussed how a lack of sight could affect the understanding of spatial concepts by VI individuals. The blind child's difficulty in understanding the concepts of "front" and "behind," as well as their inability to recognize a person's forward-facing orientation, highlights the challenges blind children face in comprehending spatial concepts. This is due to the visual nature of these concepts, as suggested by Marek (1999) and supported by previous research (Cutsforth, 1951; Harrison & Crow, 1993; Hatwell, 1985). These findings underscore the fundamental role of visual sensory input in examining spatial relations between objects.

2.2.3.2.Importance of Learning Foreign language for Visually Impaired Students

In her book *Modern Languages for All*, McColl (2000) mentioned that all learners could learn foreign languages, no matter their abilities or disabilities. Then, teachers should evaluate the potential of learners with disabilities in their first language and then adjust the process of teaching them a foreign language learning regarding their disability (McColl, 2000).

Foreign language learning proves a vital role in today's globalized world. Gray (1999) emphasized the beneficial effects of teaching foreign languages to visually impaired students (p.

254). According to the European Blind Union (EBU) in 2010, there are no significant distinctions in the reasons why visually impaired (VI) individuals and sighted individuals begin learning foreign languages. VI individuals, similar to the general population, acquire language skills through compulsory education and may have a desire or necessity to enhance their linguistic knowledge or acquire a new language (EBU, 2010).

Jedynak (2015) regarded that they undoubtedly gain many benefits from a language other than their mother tongue (p.14). First, knowledge of foreign languages, especially English, promotes VI individuals' chances of employment. Furthermore, this advantage would facilitate their integration into their society as fully able people (Araluce, 2005, p. 5).

From this point of view, Jedynak (2018) stated that the ultimate goal of education is to enable pupils to function as independent members. Consequently, foreign language learning allows people with VI to increase their professional opportunities (p. 15). From this perspective, learning foreign languages for visually impaired students could reduce the gap between the loss of sight and their environment and, consequently, their self-esteem. Within this vein, communication is the first target of any language (p. 37).

2..1.1.1. Teaching Foreign Languages to Visually Impaired Students

According to Jedynak (2018), teaching foreign languages to visually impaired learners dates back to the 1930s. In 1931, William Patrick Morrissey, a blind teacher, edited a book entitled *Teaching Foreign Languages in Schools for the blind*. This book is the first publication highlighting the potential of visually impaired persons in foreign language acquisition. In his opinion, Morrissey (1931) argued that sight loss offers new possibilities for students when they can use their auditory competence to a greater degree than fully able learners can use (as cited in Jedynak, 2018).

Therefore, Morrissey (1931) stated that visually impaired individuals are “particularly well equipped for learning foreign languages” (as cited in Araluce, 2002, p 78). He regarded their visual limitations force them to increase their hearing sense’s efficiency to a much greater extent than the average of their sighted peers. Moreover, Morrissey (1931) noticed that learning a foreign language relies primarily on the hearing sense in his book. However, even though it is a valuable aspect of learning, sight sense is not a determinant factor of success in foreign language acquisition (cited in Jedynak, 2018, p. 201).

Concerning this view, tactile stimuli are also a significant part of the learning process. In light of this view, Jespersen (1961, as cited in Nikolic, 1987) affirms that visual deficits do not obstruct a foreign language learning process because a learner acquires language through hearing sense, in the first place, rather than by sight sense. For Arenas (2012), VI people rely on the efficiency of their auditory memory and verbal ability to learn foreign languages.

Then, VI learners could learn more than one foreign language. Arenas explain that loss of sight increases the ability of memory, listening skills, and attention. She states, “Those whose main impairment is visual must therefore achieve the most, given the enhanced aural, concentration and memory skills…” (Couper, 1996, cited in Arenas 2012, p. 9). For this reason, Bacha (2007) claimed that the failure of students with problems in vision to learn a foreign language is due to a lack of adequate teacher assistance and support.

2..1.1.2. Foreign Language Teaching Approaches for Visually Impaired Students

a) Audio Lingual Method

In the 1960s, the teaching of foreign languages underwent a transnational phase. The ‘Audio-Lingual Method’ (ALM) arose due to the need for foreign language proficiency in listening and speaking skills. The ALM depended on behaviorist theory, which postulates that

human behaviour could be trained through a reinforcement system. According to Reimann (2018), receiving positive feedback is associated with the appropriate utilization of a particular trait, whereas negative feedback is received when the same trait is used incorrectly. At the heart of this approach lies the cultivation of appropriate linguistic habits, which involves mindlessly and automatically engaging in repetitive processes of reiteration, retention, and memorization of linguistic content (Komorowska, 2004, p. 22).

The ALM piqued interest in teaching foreign languages to visually impaired individuals. Schools adopted the ALM for foreign language courses tailored to the needs of blind or low vision learners. Although academic research on the method's effectiveness in schools is limited, the Dostert Report from the 1960s demonstrates its significant efficiency in language courses (Jedynak, 2018).

The Catholic Guild for the Blind (CGB) in New York implemented an ESL program for blind immigrants in the late 1960s. The program used the audio-lingual method and focused on functional language skills. Participants were required to express their desire to permanently reside in the United States and demonstrate strong motivation to quickly learn English. The program aimed to enable immigrants to function effectively in various formal and informal situations, both socially and professionally (Jedynak, 2015).

In this ESL course, the instructor provided the participants with a specific verbal prompt, such as a sentence template, the start of a sentence, or a word indicating the subject matter. Afterwards, the participants were asked to autonomously restate the prompt, and the teacher offered positive reinforcement in the form of praise as feedback, ensuring that the desired outcomes were met. In compliance with the expectations, the programme was successful. After

mastering, in verbal form, various linguistic structures, the course participants had to learn the material in the area of English Braille (Jedynak, 2015, p. 146).

- **Limitations of the ALM in Teaching Visually Impaired Students**

In the 1980s, the audio-lingual method lost its popularity, and educators started focusing more on the development of writing skills. As a result, Nikolic (1987) emphasized the importance of prioritizing writing and reading in Braille in the learners' native language, as visual impairment could hinder their acquisition of these skills in learning a foreign language. However, proficiency in the Braille system could enhance fluency in a foreign language. Students with visual impairment faced challenges because the Braille system did not facilitate easy access to all the necessary information and varied meanings in the foreign language (Nikolic, 1987; Nielson & Harvey, 1992).

According to Guinan (1997), language classes cannot solely depend on the traditional auditory-oral method (ALM) to develop listening and speaking skills for blind students. The author argues that blind students may face challenges in reading and writing skills in a foreign language due to a lack of proficiency among foreign language teachers in Braille. As a result, blind students may encounter difficulties in correcting spelling and writing foreign words, particularly in English. (Guinan, 1997).

b) Communicative methods

In his publication, “Teaching English as a Foreign Language in Schools for the Blind and Visually Impaired,” Nikolic (1987) observed that visually impaired students excel in acquiring both foreign and native languages. Their success in language acquisition is not hindered by their visual impairment. The author explored that VI students had a particular aptitude for acquiring language because of their auditory sensitivity and exceptionally trained memory. Thus, he stated

that “well-trained ears do not necessarily equate with success in language studies” (Nikolic, 1986, p. 223).

In this context, Nikolic (1987) considered teaching foreign languages to visually impaired learners through the ‘communicative method’ could provide effective outcomes. In essence, this method focuses on the extensive use of the listening comprehension exercises as the most useful ones. These tasks could involve dialogues, dramatization, lectures, and role-playing. This method produced a desirable result because students use all of their senses during the learning process. Furthermore, the oral communicative method depends on audio, oral, and tactile instructional material. Then, their aural and verbal skills and memory efficiency are decisive factors for language learning success (Nikolic, 1987).

- **Limitations of Communicative Teaching Method:**

In Jedynak’s (2015) study, it was observed that visually impaired learners lacked confidence in achieving advanced language skills. They doubted that proficiency in English would facilitate their integration into the sighted community or improve their job prospects. Teachers also noted that visually impaired students displayed limited engagement in classroom activities, resulting in low motivation and academic achievement. However, research has shown that visually impaired learners possess exceptional auditory abilities and an excellent memory, which contribute to their aptitude for language learning (Jedynak, 2015, p. 217).

Guinan (1997) suggests that communicative instructional methods are effective for visually impaired (VI) learners when teachers receive training in VI education and ESL. Additionally, ESL teachers are advised to create and modify teaching materials in Braille to meet the specific needs of VI learners. Further research is recommended to confirm the idea that sighted and visually impaired students acquire a second language in similar ways but with

different requirements. She advocates for the inclusion of all four language skills and critiques the aural-oral approach for assuming that students should prioritize reading and writing only after achieving proficiency in speaking and listening abilities (Guinan, 1997).

As Nikolic (1987), who was a blind professor of English in Belgrade, pointed out that "one of the "golden rules" of teaching is that the more senses one engages, the better and quicker is the process of learning" (p. 63). The author claimed that

> There is no specific method for teaching foreign languages to blind and visually impaired persons. Instead, teachers should choose those characteristics of existing methods they think will work best with students and help them engage in the learning process. (Nikolic, 1987, p.63)

The literature review demonstrates that individuals with visual impairments can achieve comparable proficiency in learning foreign languages to their sighted peers when their specific educational needs are adequately addressed (Araluc, 2002; Armstrong, 2011; Nikolic, 1987), auditory input (Douglas, McCall, McLinden, Pavey, Ware, & Farrell, 2009; Röder, Rösler, & Neville, 2000; Weeks et al., 2000), and assistive technology (Douglas et al., 2009; Lowenfeld, 1973; Sousa, 2013; Tobin, Bozick, Douglas, Greaney, & Ross, 1997).

2.3. Understanding Information Communication Technology as a Concept

ICT stands for Information Communication Technology (ICT). Thus, understanding the nature of this concept requires a clear distinction between the terms "information," "communication," and "technology." First, The *Thesaurus Linguae Latinae* (1900) explained that the English word "information" had its origin in the Latin words "information" and "inform." These terms refer to the "knowledge obtained from investigation, study, or instruction" (Capurro, 2011). Hence, the concept of information relates to the notion of knowledge. One

reason is that information represents a tool that provides individuals with knowledge. Consequently, they could receive, modify, or manipulate the state of their knowledge (Lombardi, 2004, p. 109).

Bell (1957) stated, “information is measured as a difference between the state of knowledge of the recipient before and after the communication of information” (p. 7). From this perspective, McCreadie and Rice (1999) considered information as the stored knowledge that a person gains. Traditionally, books have been the primary medium for storing knowledge. Nowadays, alongside books, there is an increasing trend to keep knowledge in a wide range of hardware or software devices (as cited in Madden, 2000, p. 344).

Second, communication is rooted in two Latin words: “communis” and “communicare.” The word “communis” means “to make” something “common” (Lunenburg, 2010, p. 1). Then, this definition of communication indicates the process of transmitting knowledge to produce common sense from one individual (the sender) to another (the receiver) (Keyton, 2011). This definition reveals that individuals establish communication if there is a common understanding of meaning or exchange of information between them (Lunenburg, 2010, p.2).

Furthermore, “communicare” means “to share” ideas, information, feelings, or knowledge that gain a shared understanding through mutually understood signs, semiotic rules, or united symbols from one entity or group to another. Communication also can be non-verbal. To give an example, Japanese people bow from the waist in greeting. Indian people, for example, fold their hands to greet others (Bambaeeroo & Shokrpour, 2017).

Third, the term “technology,” according to Nichols (1987), has its root in the Greek word “technologia.” This notion consists of two parts: “techne” which means “art, craft or skill” and “ology” which means “study of” (as cited in Isman, 2012, p. 208). Thus, this concept indicates

"the application of organized knowledge to practical tasks by ordered systems of people and machines" (Barbour, 1993, p. 3). In the same context, technology does not exclusively cover only human artifacts such as machines, electronic hardware, or industrial manufacturing systems. In this sense, technology is a broad definition that includes any "practical application of knowledge" or "manner of accomplishing a task" in specific fields. (Isman, 2012).

Moreover, Kumar, Kumar, and Persaud (1999) clarify that technology has two essential components: (a) the hardware as a physical component containing tools, products, and equipment. On the other hand, (b) the software is the informational component that comprises particular knowledge to manage and control the physical elements (Kumar et al., 1999, p. 82). In this light, technology as a concept is embodied in products or technical material and associated with the knowledge or information on how to use these tools adequately (Bozeman, 2000, p. 629; Lovell, 1998, p. 498).

Referring to ICT, Drigas and Ioannidou (2013) state that "Information and Communication Technology (ICT) is a general term that includes all kinds of technologies that enable users to access and manipulate information." (Drigas & Ioannidou, 2013, p. 41). Accordingly, ICTs are technological tools that make knowledge resources accessible to users. With these considerations, the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2002) clarified that ICTs are "the combination of informatics technology with other, related technologies, specifically communication technology" (UNESCO, 2002).

2.3.1. Information and Communication Technologies as Educational tools

In the age of technology, education is essential to access information and apply the required knowledge. Hence, such abilities should include knowledge and the use of ICT resources effectively (Ogunji, 2013). According to Bocconi, Dini, Ferlin, Martinoli, and Ott

(2007), students with disabilities have the full right to receive and expect the same standard of education as their fully able learners (p. 491). The authors add that learners with disabilities then "have the right to access and use mainstream educational tools, including ICT-based ones, which are generally referred to as "e-learning tools" (Bocconi et al., p. 491).

With these considerations, it is essential to clearly understand the difference between technologies used in education for fully able learners and specifically designed to meet the special educational needs of learners with disabilities.

2.3.1.1.Educational Technology

The term "educational technology" consists of education and technology. In a study, Craft (1984) shows that the root of the English word "education" backs two Latin words. Hence, this origin has two distinct meanings. Accordingly, the first word is "educare" which means "to bring up" or "to nourish." Furthermore, the second word, "educere" refers to "to bring forth" or "to draw out." An interpretation of these terms shows that education aims to provide a nourishing environment for learners to emerge and develop their latent potential (Dagar & Dhull, 1994).

From this view, educational technology, as a notion, indicates any hard and soft technologies or technical equipment used in education. However, these technologies aim to facilitate the learning process for non-disabled (fully-abled students) (Strobel, Arthanat, Bauer, & Flagg, 2007).

2.3.1.2.Assistive Technology

On the other hand, the United Nations (UN) defines "assistive technology" as those "technology adapted or specially designed to improve the functioning of people with disabilities" (Borg, Lindstrom, & Larsson, 2009, p. 1863). In education, AT includes "any item, system, or product" used to improve the potential of learners with disabilities (Edyburn, 2000).

However, assistive and adaptive technologies have interchangeable use; there is a slight difference between these two notions. On the one hand, AT is any object or tool that 'helps' people with disabilities where the focus is on enhancing individuals' abilities to accomplish an activity. On the other hand, adaptive technology is a subset of assistive technology 'specifically designed for people with disabilities. For example, technologies for hearing, speaking, or vision (Linda, 2018).

2.3.2. Historical background of Assistive Technology Legislations

In their study, Lee and Templeton (2008) state that federal legislation alongside technology evolution has resulted in the emergence of assistive technology. From a historical perspective, the Technology-Related Assistance for Individuals with Disabilities Act of 1988 (the Tech Act of 1988) provided the first legal definition for "assistive technology." In 2004, the Individuals with Disabilities Education Act (IDEA) re-defined the concept of AT. Interestingly, the IDEA did not present an alternative definition for AT, but the IDEA represented the latest reauthorization of the legal AT definition into a section entitled "Related Services."

2.3.2.1.Definition of Assistive Technology

The Tech Act of 1988 (Public Law 100-407) represented a forerunner to describe assistive technology devices as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Assistive Technology Act, 1988).

In 2004, the IDEA reauthorized the Tech Act of 1998 (Public Law 108-364), which adopted the same legal for defining the AT concept. Nevertheless, the IDEA adds an exception, which specifically excluded any medical devices that are surgically implanted. Hence, an AT

device is “any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, to increase, maintain, or improve functional capabilities of a child with a disability. The term does not include a medical device that is surgically implanted, or the replacement of such device” (Assistive Technology Act, 1988).

Considering the definition above, analyzing the language used in these regulations provides some interpretations. The words “any item” broadly cover any technology devices that can increase the independence of learners with disabilities during learning. These devices encompass low-technology (low-tech) devices such as pencil grips or high-technology (high-tech) tools such as voice-activated software (Baesler, 2018, p. 6).

Moreover, the term “product system” means the AT solutions that require multiple technology options to work together to meet the needs of learners with disabilities. One illustration could involve a student who relies on a switch attached to their wheelchair as a means of operating an augmentative communication device. (Baesler, 2015, p. 6).

Furthermore, the phrase “whether acquired commercially off the shelf, modified, or customized” refers to the outright purchase of AT equipment. Nevertheless, learners with disabilities may need specific modifications or accommodations for using AT devices. This process requires customizing technology to address their special needs (Baesler, 2015, p. 6)..

Finally, the phrase “that is used to increase, maintain, or improve the functional capabilities of a child with a disability” highlights the potential of AT to meet the user’s unique requirements. In the context of education, this statement reveals the central Task that assistive technology performs, in which students can increase, maintain, or improve their abilities during the learning process (Baesler, 2015, p. 7).

Therefore, Assistive technology comprises tools and devices enable individuals to manage disabilities. It encompasses physical hardware, software, or services aiding in overcoming limitations. An example is the use of spectacles or contact lenses to address visual impairments, widely recognized in the field (Labadie, 2019).

2.3.2.2.Types of Assistive Technology Devices

Assistive technology contains a wide range of items. Individuals with different disabilities need different AT devices. For instance, people with reduced mobility may use mobility AT aids such as powered wheelchairs. Learners with visual disabilities depend on AT devices as video or screen magnifiers for reading and listening (O'Donnell, Long, Richardson, 2016). Table 3 categorizes some types of assistive technology devices and applications by the type of disability and the objectives or tasks for using these resources (Sze, 2004).

Table 3: *Examples of Assistive Technologies for Learners with Disabilities*

Type of Disability	Objectives/Tasks	Devices	Applications
Cognitive Learning	Reading	Electronic reading machine	Kurzwell 3000
		Portable reading pens	Quickionary ReadingPen Scan-a-Word
		Portable handheld dictionaries	Speaking Language Master The American Heritage Dictionary
		Instructional software	My Reading Coach
	Language Arts	Instructional software	Simon Sounds It Out
	Writing	Word Cueing and PredictionPrograms	Co-Writer
		Speech Synthesis software	Write: Outloud Intellitalk II

Continued

Type of Disability	Objectives/Tasks	Devices	Applications
	Writing	Speech recognition software	DragonDictate ViaVoice
		Spelling, grammar, and style checkers	Write This Way
	Note-taking	Portable keyboards	Alphasmart 2000
	Mathematics	Instructional software	Math for Everyday LivingMath Sequence
	Mathematics	Talking calculators	Radio Shack Talking Calculator
	Auditory memory	Portable prompting devices	Mobile Digital Recorder
Visual	Reading	Video magnifiers	Aladdin Pro+ Magni-Cam
		Scanner/OCR systems	Reading Edge
		Braille translation software	Duxbury Braille TranslatorMegaDots
	Computer access	Screen magnification software	Vista PC1 SoomTextXtra MAGic
	Mobility	Low-tech aids	Long cane
	Listening	Electronic aids	Mowat Sensor Sonic Pathfinder
Hearing	Listening	Assistive listening devices	Hearing aids Personal FM Educational SystemEasy Listener
Communication	Augmentative communication	Dedicated AAC	DynaVo 3100 Liberator II
Hearing Communication	Speech	Speech training software	Speech Viewer III
Physical	Seating and positioning	Forms and cushions	TumbleForms PinDot
	Mobility	Powered wheelchairs	Action Storm Series Power
	Environmental control	Environment control units	PowerLink 3 Control Unit Relax II
	Activities of daily living	Low-tech devices	Various reaches and grippers

Continued

Type of Disability	Objectives/Tasks	Devices	Applications
	Computer access	Keyboard modification	Accessibility Options Easy Access (Apple)
	Computer access	Alternative pointing services	Headmater2000

Source. Sze (2009, pp. 424-425).

2.3.2.3.Levels of Assistive Technology Devices

Generally, AT devices falls into three main categories: (a) low-tech, (b) mid-tech, and (c) high-tech (Constantinescu, 2015; Ganschow, Philips, &Schneider, 2001). However, some consider only two types of AT for persons with disabilities: (a) low-tech and (b) high-tech (Reichle, 2011).

a) **Low-tech:** are non-electronic AT devices. Furthermore, they are accessible, cheap, and easy to adapt for students with disabilities. For VI learners, slate and stylus (Appendix C) are low-tech AT resources. Such AT device type does not require onerous training (Alkahtani, 2013; Constantinescu, 2015; Cook & Hussey, 2002).

b) **Mid-tech**: devices are electronic devices that are easy to use with students with disabilities. However, they require little training, and their maintenance is not complicated. Mid-tech devices include talking calculators, adapted keyboards, and electronic dictionaries (Alkahtani, 2013; Constantinescu, 2015).

c) **High-tech:** devices are generally expensive and difficult to find. Moreover, they are more complex electronic devices that require individualized setup and customization. For example, Dragon Naturally Speaking is a high-tech AT for voice recognition (Cook & Hussey, 2002). Universally, AT's low-tech, mid-tech, and high-tech categorization seems to be used most often. It is generally based on technology, cost, and availability (Constantinescu, 2015).

2.3.3. Assistive Technology Outcomes on Education

In her book *Achieving impact in research,* Denicolo (2013) stated that "impact in its simplest definition is about making a difference, so there is action or activity which leads to change, but that change needs to be seen within a context which may be global, local or even individual" (p.2). Denicolo (2013) added that "the nature of the change needs to be considered, whether it is related to people, systems, environment, knowledge, understanding or policy" (p. 2). Hence, the impact is the influence of an action or phenomenon on something or someone. On the other hand, the effect is the consequence or outcome of an action or a phenomenon (Collins Cobuild Dictionary, 1990). This means that impact refers to how a consequence of some action will affect someone or something.

a) Improving Students' Educational Performance

With the enhancement of reading and writing comprehension, in most of the articles (Chiang & Jacobs, 2010; Ghazi Abed, 2018; Harper, Kurtzworth, & Marable, 2016; Nordstrom, Nilsson, Gustafson, & Svenson, 2018), the teachers reflected that the integration of technology in the classroom enhanced student's academic performance in the classroom environment. Researchers reflected on LSP (Livescribe Pen), which increased the child's participation in all educational activities and deepened the connection between reading and writing (Harper et al., 2016).

Teachers asserted that students could profit from e-learning environments by organizing and planning their work under teacher expectations and achieving higher academic results (Ghazi Abed, 2018). Additionally, by using assistive technology, students were better able to participate independently in class and appeared to have a more positive opinion of their learning abilities (Chiang & Jacobs, 2010; Nordstrom et al., 2018).

In contrast, teachers claimed that special education faculty members' teamwork collaboration is critical to how well students achieve academically (Harper et al., 2016; Ghazi Abed, 2018). For instance, the teacher works with the special education consultant and the academic intervention service teacher to give the students tailored teaching based on their specific requirements (Ghazi Abed, 2018; Harper et al., 2016).

b) Self-Esteem and Confidence

The findings of four articles: Chiang and Jacobs (2010), Harper et al. (2016), Ghazi Abed (2018), and Nordstrom et al. (2018), showed that technology could help children with learning difficulties support their self-determination and good feelings. After using the software in a classroom lesson, teachers claimed that technology improved students' perceptions of themselves (Chiang & Jacobs, 2010). In recent research, 60% of teachers answered favorably regarding their students' desire to do their homework; however, 40% of teachers stated that it depended on the children's usage of it as valuable tools, their interest in learning, and their motivation (Nordstrom et al., 2018).

After using the software in a classroom lesson, teachers claimed that technology improved students' perceptions of themselves (Chiang & Jacobs, 2010). In recent research, 60% of teachers answered favorably regarding their students' drive to complete their coursework; nevertheless, 40% of teachers stated that it depended on the children's usage of it as useful tools, their interest in learning, and their motivation (Nordstrom et al., 2018). For instance, assistance from family members and school officials. However, the instructors stressed the usage of assistive technology by promoting student autonomy, motivation, and the idea that it would be helpful in boosting their self-assurance and respect (Ghazi Abed, 2018; Harper et al., 2016).

c) Reading Enhancement

Teachers regarded AT devices as useful alternative resources for the learning development of children with reading difficulties (dyslexia) (Chiang & Jacobs, 2010; Ghazi Abed, 2018; Harper et al., 2016; Nordstrom et al., 2018). The researchers used K-3000 as an intervention program to facilitate children's reading enhancement, and teachers reported its effectiveness in improving children's reading comprehension in terms of speed, quantity, and quality (Chiang & Jacobs, 2010). Similarly, Ghazi Abed (2018) analyzed special education instructors' opinions and stressed the usefulness of text-to-speech and optical character recognition (OCR) tools for children with reading impairments.

The special education teachers responded positively about the impact of using the assistive technology apps on their students' ability to assimilate text. Teachers also pointed out that AT could compensate for their reading difficulties after using a six-week app intervention (primarily with text-to-speech, TTS, and speech-to-text, STT functions) (Nordstrom et al., 2018). Screen readers, speech-to-text, and word prediction software were helpful tools to enhance literacy teaching according to teacher perceptions of their use and effectiveness of technological software to serve children with high-incidence impairments (Flanagan et al., 2013).

d) Development of Writing Skills

In four study investigations (Chiang & Jacobs, 2010; Ghazi Abed, 2018; Harper, 2016, and Nordstrom et al., 2018), teachers noted an improvement in children's writing development. It demonstrated the effectiveness of K-3000, a software application used to check word structure and spelling (Chiang & Jacobs, 2010), and the utilization of intervention sessions that raised awareness and understanding among students participating in written and oral language programs (Nordstrom et al., 2018).

They indicated that using the right apps increased the abilities required for reading comprehension in writing, such as better access to vocabulary and comprehension of written language. Additionally, the apps were thought to improve writing abilities, particularly concerning text structure. Livescribe Pen (LSP) was used as an intervention that produced data on word vocabulary development, the ability to make bullet points, and thorough writing (Harper, 2016).

The SEN teachers emphasized using word processing tools like word processors and text-to-speech applications, which benefit students in terms of writing production and help raise writing accuracy levels (Ghazi Abed, 2018). The teachers expected that text assimilation and communication through apps would make it easier for students to develop the comprehension abilities they require, like better access to vocabulary and spelling (Nordstrom et al., 2018).

2.3.3.1.Challenges to the Accessibility of Assistive Technology

The World Health Organization estimated about 10 % of all the people who need AT worldwide have access to them (WHO, 2016). Several studies reveal that limiting effective AT use is likely to arise from an interaction between several factors (Ampratwum, Offei, & Ntoaduro, 2016; Kelly, 2011; Oira, 2012; UNESCO, 2019; WHO, 2016). From this point of view, the following issues include, but are not limited to, the significant limitations to the effective use of technology tools in education.

a) Planning Policy

Purposeful planning of how students will use AT to meet their educational needs is critical to increasing AT's effectiveness. Studies show that a lack of planning for successful implementation is often due to a deficiency in determining specific realistic outcomes for using assistive technology by learners with learning disabilities (Fuhrer et al., 2003). Nevertheless, no

structured programme should be applied to allow regular or systematic use of technology in the classroom (Carey & Sale, 1994).

b) Training Obstacles

Todis and Walker (1993) argued that if school staff were not aware of the purpose of the AT, training students to use devices became the long-term focus rather than a practical application to build on students' academic and social skills. Continuous training in device use occurs at the expense of goal achievement (Todis, 2001). According to Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012), inadequate professional development and training is the most commonly cited reason for the lack of technology implementation in the classroom.

c) Funding Constraints

In their study, Derer, Polsgrove, and Rieth (1996) reported that teachers considered the lack of AT provision due to the high costs of these adaptive devices and applications. Hence, schools have access to fewer financial technology resources than required to meet the educational needs of students with learning disabilities (Hutinger, Hall, Johansen, Robinson, Stoneburner, & Wisslead, 1994). Furthermore, another critical challenge is that hardware and software technology will need to be updated and upgraded continuously as the learners grow. Thus, these resources' costs will not be available to all users (Swinth & Case-Smith, 1993).

Besides, the hidden cost of equipment maintenance places a heavy burden on service providers to decide which appropriate technology devices to purchase (Cowan & Turner-Smith, 1999; Swinth & CaseSmith, 1993). However, additional costs are routinely required for customization, replacement, maintenance, and training to use equipment (Noha, 1992).

d) Equipment Issues

Difficulties in locating and obtaining equipment can be disruptive and time-consuming for students (Derer et al., 1996). Once AT equipment is ordered, a long wait may ensue before it arrives and is ready for student use (Carey & Sale, 1994; Cowan & Turner-Smith, 1999; Margolis & Goodman, 1999). Furthermore, when equipment breaks down, students and their teachers must work without AT for a considerable time until the manufacturer or supplier repairs the equipment (Carey & Sale, 1994; Hutinger et al., 1996).

The design of an AT tool represents a determinant factor in adopting or abandoning decisions. Accordingly, the hack of the portability of a technology device is a problematic factor. The reason behind this is that the inflexibility of AT force individual to use it in a few settings. This situation is a constant source of frustration for students who need to use the technology behind school walls (at home) to complete their homework (McGregor & Pachuski, 1996; Priest & May, 2001; Scherer & McKee, 1990).

Time constraints

The time required to obtain equipment, install it, and train teachers and then students to apply the technology represents a significant challenge for both teachers and students to use adaptive technologies to their full potential (Carey & Sale, 1994; Derer et al., 1996; McGregor & Pachuski, 1996). Moreover, additional time is required to replace equipment from one setting to another and diagnose the reason behind the malfunctions of these technology devices and services (Carey & Sale, 1994).

Attitudes and Knowledge Effects

For learners with disabilities, their attitudes and beliefs determine the role and effectiveness of using assistive technology in classrooms. This aspect would ultimately influence how learners implement technology. According to Brain (1928), “attitude is the relatively stable

overt action of a person which affects his status in groups" (p.957). Consequently, positive attitudes toward assistive technology help to extend students' participation in their education activities (Chapelle, 2010).

In this context, learners' specific attitude toward a particular technology depends upon whether the student's perception of such technologies facilitates or blocks some cherished values the scholars hold. Thus, Sanchal and Sharma (2017) stated that attitudes contain cognitive, affective, and behavioural reactions individuals display towards an object or the encompassing supported feeling. Regarding using AT, some students with VI were reported to lack knowledge of using computer-assistive technology. Ampratwum et al. (2016) declared that VI learners are often not aware of the potential of ATs to enhance education. In light of this, education may be a systematic process that yields encouraging changes within the behaviour and lifetime of humans (Ampratwum et al., 2016).

2.3.3.2. Considerations for Effective Assistive Technology Resources

The spectrum of visual impairment varies widely from person to person. Thus, every visually impaired individual is different. The Assistive technology use should be based on a person's potential and impairment level. In this context, Maurya (2017) suggested some characteristics for selecting the appropriate assistive technology tool.

a) **Adaptability**: Assistive technologies should be available for all users, to which they have equal access due to the sufficient quantity of these products and services. Thus, persons with disabilities can easily benefit from AT.
b) **Accessibility:** Accessibility relates to physical access and the cognitive aspect of using AT resources. Using Braille digital products is an example of physical accessibility. On the other hand, cognitive accessibility means that the input or the output information

should be clear and simple for users using concrete language and symbols rather than abstract.

c) **Affordability:** The cost of assistive technology products is a significant factor in the appropriate selection. That is to say that every family of a person with a disability could afford it. According to standard rules on equalizing opportunities for persons with disabilities (1995), some families cannot afford them.

d) **Adaptability:** Assistive resources should be manufactured so that it is adaptive to meet the requirements and needs of students with disabilities. For instance, environmental factors such as climate, culture, physical, and psychological environment. Individual characteristics include age, gender, health conditions, ethnicity, capacity, and preference. These elements should be considered while selecting and providing AT devices.

e) **Quality:** Selecting the appropriate AT quality can significantly increase the level of benefit those services and products that learners with disabilities use. Capacity, comfort, durability, safety, and strength are some of the technical guidelines that can measure the quality of AT devices. In light of this, the quality of products should comply with the International Organization for Standardization (ISO) ***(***Maurya, 2017, pp. 39-40).

2.3.4. Assistive Technology and Visually Impaired Students

Visual impairment has different levels, i.e., low vision or blindness. In this context, visually impaired learners need assistive technology according to their visual deficiency. Therefore, a wide range of devices and applications are designed for different purposes for visually impaired students (table 4).

Table 4: *Assistive Technologies of Accessibility for Individuals with Visual Impairment*

Method of Access	Device	Description
Braille Embosser	Mountbatten Brailler	Electronic Braille embosser that translates text from a Braille keyboard to a printer
Braille Translator	Duxbury Braille Translator	A software program that takes a computerized text file and converts and formats the document properly for printing
Braille Writer	Perkins Brailler	A machine with keys corresponding to each of six dots of the Braille code to create all characters of the code
Global Positioning System (GPS)	Trekker	(Hardware) An orientation tool system that determines the position such as intersections and allows one to plan and follow routes by communicating with satellites in the earth's orbit
	BrailleNote	(Software) A mobility system that allows the user to generate or understand and develop routes throughout the environment
Optical Character Recognition (OCR)	Kurzweil Reader, OpenBook	A system that provides the capacity to scan printed text, have it spoken in synthetic speech, or save it to a computer file
Synthetic Speech	JAWS, Window-Eyes	Screen reading software that allows text to be converted to speech
Video Magnifier	Closed Circuit Television (CCTV)	Hardware used to project magnified images onto a video monitor

Source. Gargiulo (2012, p. 475)

Therefore, the AT tools available for VI learners can fall into three categories.

a) **Back-end AT tools:** They refer to some technologies that conduct the functions relevant to one specific or a range of AT, irrespective of output format, but do not directly interface with the AT user. Such back-end tools may (Pal, Pradhan, Shah, & Babu, 2011, p. 514).

b) **Input AT resources:** They indicate how people with visual impairments communicate with the computing interface. The input devices vary depending on the user's functional vision or hearing level (Pal et al., p. 514).

c) **Output AT devices:** The output for people with vision impairments depends on their level of functional vision and hearing, and accordingly, AT technologies can be tactile, visual, or audio output products or devices (Pal et al., 2011, p. 515).

2.3.4.1.Assistive Technology Practices in the Learning of Students with Visual Impairment

Currently, providing information in an accessible format utilizing assistive technology (AT) is required to improve the learning and involvement of students with VI in inclusive educational environments (Alves, Monteiro, Rabello, Gasparetto, & Carvalho, 2009). In this context, existing literature defines AT as any acquired, modified, or customized resource or facility that helps a person with a disability increase, maintain or improve their functional capacities (Zhou, Parker, Smith, & Griffin-Shirley, 2011).

With the introduction of modern equipment and technological advancements, AT has effective outcomes in enhancing the learning of visually impaired students. Table 5 below summarizes some of the essential assistive technology tools for students with visual impairment.

Table 5: *Examples of Assistive Technology Tools for Students with Visual Impairments*

Adaptive Hardware	• Refreshable Braille displays • Screen enlargement peripherals • Speech synthesizers • Printers • Braille embosser • Electronic note-takers • Voice output devices • Braille input/output devices
Adaptive Software	• Braille translation software • Screen readers • Screen enlargement software • Speech recognition software
Use of Adapted Output Systems	• Enhanced image systems • Synthesized speech systems • Refreshable Braille displays • Use of Braille printers

Continued

Use of Adapted Output Systems	• Enhanced image systems • Synthesized speech systems • Refreshable Braille displays • Use of Braille printers
Use of Adapted Input Systems	• Braille input devices • Use of voice recognition systems • Use of optical character recognition (OCR) systems

Source. Gense and Gense (1997) (as cited in Gargiulo, 2012, p. 476)

a) Text-to-Speech Software: These programs allow people to listen to written information read aloud by a human-recorded or synthesized voice. The passage is highlighted on the screen simultaneously, allowing the reader to follow along. "Speech synthesis is a tool that reads aloud computer-based text using digitized or synthesized speech" (Lange, Lee, & Dai, 2006, p. 154).

b) Braille Reading Materials: Braille codes have been developed for many languages worldwide using standard rectangular cells, encompassing up to six dots in a two-by-three grid (Spungin, 1990). Higher educational achievement, self-esteem, and greater financial self-sufficiency were positive outcomes reported in research on the instruction and reading of Braille (Ryles, 1997; Schroeder, 1996; Stephens, 1989).

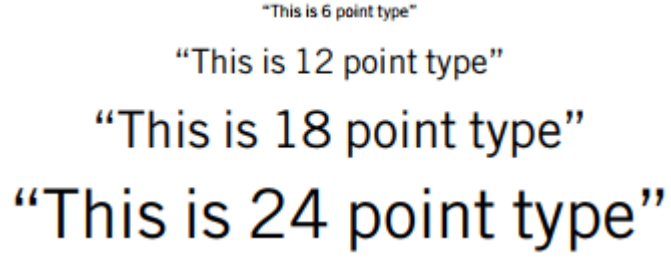
c) Text-to-speech software. Students with VI and blindness may benefit from talking word processors to improve their spelling and composition (Angelocci & Connors, 2002; Erickson, 2004; Nicohls, 2013). Students may benefit from combining the usage of traditional word processors with screen and document reading technologies, such as Job Access with Speech (JAWS) by Freedom Scientific or Kurzweil 3000 by Kurzweil Educational Systems.

d) **Screen and document reading software**: According to the American Foundation for the Blind (AFB, 2013), visually impaired students struggle to read written materials or type on computer displays. Reading software may be used to make reading content more accessible. Students could use this program to turn text on displays and documents into synthetic voice (i.e., audio output) (AFB, 2013). Common screen and document reading software include NonVisual Desktop Access (NVADA), JAWS, and Kurzweil 3000 (Gierach, 2009).

e) **Audio devices**: Students with VI and blindness may benefit from making audio speech recordings in classroom situations where accuracy and speed of note-taking or writing are critical. For example, SVI may use electronic devices such as cassette players to record lectures or books in audio formats (Attmore, 1990).

f) **Large print text**: Accordingly, low-vision individuals commonly require magnification to read print material (Lueck, Bailey, Greer, Tuan, Bailey, & Dornbusch, 2003). According to the American Foundation for the Blind (AFB, 2013), using large-print text is one method for improving reading comprehension levels. Large print papers usually have a font size of 18 or more (Kitchel, 2013). Figure 7 demonstrates the difference between font sizes ranging from 6 to 24-point types.

Figure 7*: Illustration of the Difference between Four Font Sizes*



Source. Gargiulo (2012, p. 461).

Moreover, margin size, color contrast, spacing between text lines, the distance between the reader and text materials, the number of characters per line, and readability are influenced by various other elements (AFB, 2013; Kitchel, 2013; Lueck et al., 2003). Word processors, for example, could produce large print documents for on-screen viewing or printing (Evans & Blenkhorn, 2004).

2.4. Reading Fluency

According to the International Literacy Association (2018), comprehension and motivated reading are crucial outcomes of fluency. In this context, Hasbrouck and Glaser (2012) defined the concept of "reasonably accurate reading, at an appropriate rate, with suitable expression, that leads to accurate and deep comprehension and motivation to read" (p. 13). In this definition, three elements are critical: accuracy, rate, and expression. The National Reading Panel defines fluency as reading text with "speed, accuracy, and proper expression" (National Institute of Child Health and Human Development [NICHD], 2000, p. 3).

Students are observed to read fluently when their oral reading sounds like conversational speech (Hudson, Lane, & Pullen, 2005). Fluency, according to Fujita and Yamashita (2014), is divided into four categories by mechanical/automaticity, "accuracy," reading speed, and "prosodic structuring" (as cited in Andy & Muzamil, 2018, p. 517). According to Andy and Muzamil (2018), the first is concerned with express activity in handling, which is difficult to restrain and is a little resource- and intervention-free.

The second concerns "fluent" lexical identification that is explicit, mechanical, thorough, and precise. Regarding the third, reading with a quick rate refers to time spent in general reading glibly without experiencing difficulties comprehending the entire passage. Last but not least is

the ability to correctly understand passage chunks, a skill that is gained as the foundation of reading with emotional sensitivity (p. 517).

Reading fluency has typically been disregarded in the second language (L2) or foreign language (FL) learning contexts (Grabe, 2009; 2010). Accurate word decoding has received greater weight than automaticity, or speed could be a significant factor in this absence (Davies, 1982; Rasinski, Homan, & Biggs, 2009). According to Naghdipour (2015), reading passages in English takes longer to digest because it involves coming across new vocabulary, meaning-content collections, formulae for creating sentences, and systems for reading (either from the left or right).

Although reading speed is not a finite determinator of fluency, reading at the standard reading rate would significantly enhance reading fluency. Oral reading fluency (ORF) as measured in words correct per minute (wcpm). According to the International Literacy Association (2018), “students do not need to read as fast as possible to become good readers. Students who read in the average range of ORF norms are on target to become effective readers; they are doing just fine” (p.5).

According to Allington (1983), reading fluency was once considered the "neglected" goal of reading, but things have changed dramatically over the last three decades. Fluency is recognized as a critical component of proficient reading, and the National Reading Panel Report labeled it one of the five "fundamental principles" of early reading instruction (NICHD, 2000). Most literacy educators today believe fluency is essential for successful reading development (Rasinski, Blachowicz, & Lems, 2006; Samuels, 2006).

Furthermore, numerous other positive reading outcomes have been strongly connected to reading fluency. According to Oakley (2005), proficient readers enjoy reading more, have more

favorable views toward reading, and have a more positive self-concept as readers than less fluent readers. It has been proposed that fluency and comprehension in Braille readers are related in similar ways (Harley, Truan, & Sanford, 1987; Koenig & Holbrook, 1989).

In the context of both EFL and ESL, Reading is challenging due to poor lexical item identification abilities, claim Gorsuch and Taguchi (2008). The process of overcoming this deficit is challenging. They contend that teachers dealing with L2 children should emphasize fast and precise lexical item identification to increase reading fluency. According to research, numerous L2 readers read laboriously and far more slowly than they would in their native tongue (Fraser, 2007; Nation, 2005). Slow reading can signify poor comprehension, a lack of automaticity in word meaning determination, and a disinterest in the reading experience. According to Nuttall's oft-quoted statement (1996), "speed, delight, and comprehension are all interwoven" (p. 127).

2.4.1. Braille Reading Fluency and Visually Impaired Students

For sighted people, literacy skills are as crucial as for those with low vision. Interaction with Braille is required for visually impaired individuals because they cannot use the print medium. Braille is a tactile phonetic alphabet system invented in the early 1800s by a blind teacher, Louis Braille (Jiménez, Olea, Torres, Alonso, Harder, & Fischer, 2009). Ryles (1996) found that the visually impaired who learned Braille were more likely to be employed and obtain a college degree than those who did not learn Braille.

Moreover, The Braille readers in Ryles' study had better reading habits, such as reading more hours per week, buying more books, and subscribing to more publications. This phenomenon mimics the beneficial impacts of reading skills shown in sighted readers. Hence,

higher literacy levels could be associated with better employment outcomes for both Braille and print readers (Koenig & Holbrook, 2000; Kutner et al., 2007; Ryles, 1996; Wolffe & Kelly, 2011).

Furthermore, reading proficiency improves the emotional well-being of students with visual impairments (Ferrell, Mason, Young, & Cooney, 2006). For instance, Higher levels of independence, confidence, and self-esteem relate to Braille literacy (National Federation of the Blind Jernigan Institute, 2009; Schroeder, 1996; Wells-Jensen, 2003).

2.4.1.1.Braille Reading

Braille readers could read words accurately but do so very slowly (Trent & Truan, 1997; Wetzel & Knowlton, 2000). For sighted readers, fluency, which is a powerful predictor of comprehension, has not yet been developed in these pupils (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Klauda & Guthrie, 2008; Wolf & Katzir-Cohen, 2001). Although there are many possible causes for why Braille readers may struggle to reach reading comprehension levels comparable to those of their sighted counterparts, print-based reading research has repeatedly connected dysfluency with subpar reading results (Chard, Vaughn, & Tyler, 2002; Fuchs et al., 2001).

When readers struggle to interpret words accurately, they might not be able to comprehend the text's meaning fully. Recent studies provide evidence that Braille users may benefit from techniques proven to boost print readers' fluency, improving their reading achievement and, ultimately, their long-term academic success (Munro & Munro, 2013; Pattillo, Heller, & Smith, 2004; Savaiano & Hatton, 2013).

2.4.1.2.Reading Speed of Visually Impaired Students

For instance, Oakley (2005) discovered that the more fluent readers like reading, the more they have favorable attitudes toward reading and have a more favorable conception of themselves as readers than less fluent readers. According to some, Braille readers' fluency and comprehension may relate similarly (Harley, Truan, & Sanford, 1987; Koenig & Holbrook, 1989).

Braille reading rates were first evaluated in the second part of the 20th century. In his 1979 study of the literature on Braille reading, Foulke concluded that Braille readers could not reach rates comparable to their sighted contemporaries because of the serial structure of Braille reading, which is required by the constraints of tactile perception. A good Braille reader is said to read at roughly 1/3 to 1/2 the speed of a print reader of the same age (Pring, 1994).

Although few braille readers can read at speeds comparable to the average print reader, most of them read between one-third and one-half as quickly as their sighted peers (Ferrell, Mason, Young, & Cooney, 2006; Legge, Madison, & Mansfield, 1999; Morris, 1966; Simon & Huertas, 1998). Adults who read Braille typically read between 70 and 100 words per minute compared to 200 to 300 words per minute for print readers. However, the subject of Braille's reading speed is debatable.

As assessed by Knowlton and Wetzel in 1996, the average speed among seasoned Braille readers was 136 words per minute, ranging from 65 to 185 words per minute. Many more people have reported rates like this (Legge, Madison, & Mansfield, 1999). For much of the 20th century, Braille's research was dominated by attempts to ascertain ideal reading rates and to pinpoint the most effective hand movements needed to increase reading speed. At least one study of seasoned adult Braille readers indicated that less than one-third of Braille readers read slower than print

readers, despite the likelihood that young Braille readers read slower than print readers of the same age (Wetzel & Knowlton, 2000).

Similar to braille readers, readers of enlarged or magnified print have reading rates that are only marginally higher (Corn et al., 2002). Interestingly, these depressed averages haven't changed much over the years, indicating that they have nothing to do with changes in instructional methods, environments, or learning opportunities (Jackson & Presley, 2012, p. 2). At particular grade levels, teachers can determine minimum benchmarks for Braille readers and examine average oral reading rates for sighted readers. These are merely guidelines, though, as every pupil is different (Koenig & Holbrook, 2000; Wall Emerson, Holbrook, & D'Andrea, 2009; Wormsley, 2004).

Chapter Summary

In this chapter, the literature review highlighted assistive technology use in the field of visually impaired learners' education. There are various supporting tools for learning English as a foreign language using tactile, kinesthetic, or auditory learning and accommodations. These resources depend on the student's visual deficiency level. Studies showed that AT is an intrinsic enabler. In other terms, AT could bridge the gap in quality learning among SVI.

However, these studies focused on teachers' perspectives which reveal that assistive technology may have a significant effect in helping students with learning disabilities to meet the goals of their learning development. Thus, they neglected the experience and role of visually impaired students as the primary users of assistive technology tools. Besides, these studies didn't provide promising evidence-based English teaching and learning practices.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

This chapter explains the current study's methodological choices and research design. They mainly relied on the philosophical stances that guided this inquiry. More specifically, the researcher discussed the approach implemented to enhance the reliability and validity of this investigation. In addition, the investigator provided information on the sampling technique for selecting participants, that is, the criteria for inclusion in this study. Additionally, this chapter outlines the methodologies for gathering, examining, and presenting data. Finally, the researcher described procedural considerations for ethical issues.

3.1. Research Methodology

Research, as a concept, reveals the meaning of a search for new knowledge. This latter is a hidden truth that an investigator seeks to discover. Accordingly, Redman and Mory (1923) described the term "research" as a "systematized effort to gain new knowledge" (p.10). In other terms, research, as a process, aims to generate an original contribution by giving new knowledge to the existing stock of scientific evidence (Bist, 2014, p. 34).

In the same context, Remenyi, Williams, Money, and Swartz (1998) indicated that "research methodology" is "the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data" (as cited in Witt, West, & Martir, 2016, p.119). However, a methodology does not suggest solutions for a particular problem (Irny & Rose, 2005). This definition reveals that "methodology" represents the entire research study process, which begins with the theoretical underpinnings, systematically collects data, and then analyzes findings to solve the research problem (Patel & Patel, 2019, p. 48).

With these considerations, The procedures used by researchers to describe, explain, and anticipate events of interest are referred to as research methodology (Sayer, 1992). Hence, the focus concerns not only explaining "how" a researcher systematically designs a study. Instead, an investigator highlights "why" particular methodological choices are appropriate rather than using others to address the research objectives (Tavakoli, 2012, p. 549). More precisely, According to Creswell (2009), researchers employ a research methodology that encompasses the systematic steps they undertake to address the research questions they have identified (Chivanga & Monyai, 2019).

3.2. Research Design

Research design relates to the framework or the conceptual plan that provides data collection and findings interpretation (Heppner, Kivlighan, & Wampold, 1992, p. 15; Sileyew, 2019). Under this view, Creswell and Poth (2016) considered research design, for an inquirer, as a "pattern" to (a) collect, (b) analyze, and then (c) interpret the required data (p. 293). Thus, for selecting a research design, the researchers should consider "what" data they must gather and "how" to analyze these data (Aaker et al., 2008). According to this viewpoint, a researcher can predict and describe seemingly unrelated decisions related to gathering, interpreting, and analysis data (Manheim, 1977).

Within a case study framework, this study employs an approach that combines of qualitative and quantitative methodologies. A mixed methods design integrates different strategies, either quantitative or qualitative, into a single study. These additional strategies complement the primary or central method and contribute valuable insights or indications that are further explored within the main method (Morse, cited in Tashakkori & Teddlie, 2003, p. 190). The mixed method design, therefore, involves collecting, analyzing, and integrating

quantitative and qualitative data in a single or multiphase study. This design shows a practical comprehension of a pragmatic epistemology (Guba & Lincoln, 1994).

Mixed methods research design combines qualitative and quantitative approaches to collect and analyze data (Creswell & Tashakkori, 2007). Leedy and Ormrod (1993) considered that qualitative research highlights the first-hand experience (s) for providing the most meaningful data (as cited in Mohajan, 2018, p. 24). For this purpose, visually impaired students were the central information resource for the current study to collect qualitative data.

On the other hand, Quantitative research revolves around making predictions and employing numerical symbols to validate or invalidate a hypothesis. This type of research emphasizes stringent control of variables. It centers on a fixed reality in the form of numbers, where data is generated from a sample of study participants, allowing researchers to generalize their conclusions to a broader population (York, 1998).

This choice was relevant to this study's purpose. Hence, the ultimate goal of this inquiry attempted to establish qualitative evidence for understanding the participants' lived experiences of the impact of their AT use on the TEFL process. In this context, the qualitative research approach is the dominant approach for this study to present a holistic understanding of a specific event or natural social setting (Ary, Jacobs, & Sorenen, 2010, p. 29). Therefore, using mixed methods could provide detailed and comprehensive data and interpretation of data.

In considering the type of mixed methods strategy of inquiry for this study, the researcher reflected on four criteria as suggested by Creswell (2003, p. 211):

a) **Theoretical Perspective:** It pertains to the fundamental philosophical framework or paradigm (such as post-positivism, constructivism, or feminism) that forms the basis of a study and influences the subsequent methodological decisions.

b) **Implementation:** It necessitates deciding whether to collect qualitative and quantitative data simultaneously or successively.

c) **Priority:** It refers to the degree of importance assigned to the two types of data, whether they are treated as equal or unequal in significance.

d) **Integration**: It implies to the incorporation of quantitative and qualitative data at various stages of a study, including data collection, analysis, or interpretation (Creswell, 2003, p. 211; Hanson, Creswell, Clark, Petska, K. S., & Creswell, 2005, p. 227).

With these considerations, Table 6 illustrates the decision choices for using a mixed method strategy adopted by the researcher in this study

Table 6: *Illustration of Decision Choices for a Mixed Methods Strategy*

Design type	Implementation	Priority	Integration	Theoretical Perspective
Sequential Exploratory	Qualitative followed by Quantitative	Qualitative	Interpretation phase	Pragmatism Paradigm

3.3. Research Paradigm

Mills, Bonner, and Francis (2006) recommend that "to ensure a strong research design, researchers must choose a research paradigm that is congruent with their beliefs about the nature of reality" (Mills, Bonner, & Francis, 2006, p. 2). Thus, understanding the nature of a research paradigm could frame how a researcher would tackle the research process. In addition, as a scientific philosophy, the research paradigm could enable researchers to generate insights into knowledge in the research (Žukauskas, Vveinhardt, & Andriukaitienė, 2018).

Initially, the origin of "the term "paradigm" derives from the Greek word *paradeigma,* which means pattern"(Antwi & Hamza, 2015, p. 218). In light of this, the American philosopher "Thomas Samuel Kuhn" (1922-1996) was the first who use this concept in his book "*The*

Structure of Scientific Revolutions" in 1962. Kuhn (1962) defines this notion as "the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed" (Kuhn, 1962, p. 45).

According to this definition, the concept of paradigm refers to a collection of shared views, assumptions, and values shared by a community of researchers (Kuhn, 1962). Therefore, a paradigm is not a theory. It is the lens to choose particular theories and methodologies in a research study (Creswell, 2003; Musa, 2013). In simple terms, a paradigm and a researcher's 'worldview' are two sides of the same coin (Mackenzie & Knipe, 2006). According to Chilisa and Kawulich (2012, p. 1), it was argued that a paradigm provides researchers with a framework to pose precise inquiries and employ suitable approaches and methods for conducting systematic investigation.

3.3.1. Pragmatism as a Research Paradigm

The research was grounded in the pragmatic paradigm, which prioritizes practical effectiveness rather than absolute and objective notions of "truth" or "reality". Pragmatism, as a research paradigm, avoids engaging with controversial philosophical concepts such as truth and reality within this framework. Instead, it recognizes the potential of one or more realities that can be empirically investigated (Creswell & Plano Clark, 2011). pragmatists hold the view that all knowledge in our world is a product of social construction. However, certain versions of these social constructions align more closely with individuals' experiences than others (Morgan, 2014a).

Therefore, pragmatist scholars put forth the argument that knowledge claims cannot be fully detached from contingent beliefs, habits, and experiences (Howe, 1988). In light of this perspective, pragmatist scholars emphasize that knowledge is intricately tied to personal

experiences. Our social interactions and encounters shape how we perceive the world. Each individual's knowledge is distinct and influenced by their unique experiences. Consequently, all knowledge is considered to be socially constructed (Morgan, 2014a). In pragmatist epistemology, knowledge is not seen as an objective reality (Rorty, 1980). Instead, it is viewed as a tool for effectively navigating and participating in the world (Goldkuhl, 2012).

Positivist researchers argue for the acquisition of objective knowledge through the examination of empirical evidence and hypothesis testing, while constructivists emphasize subjective perspectives. In contrast, pragmatists perceive knowledge acquisition as a continuum, rejecting the notion of objectivity and subjectivity as opposing and mutually exclusive concepts (Goles & Hirschheim, 2000). Postpositivism commonly emphasizes quantitative approaches and logical reasoning, whereas constructivism emphasizes qualitative approaches and inductive reasoning. Pragmatism, on the other hand, embraces both sides of the spectrum and provides a reflective and flexible approach to study design (Feilzer, 2010; Morgann, 2007; Pansiri, 2005). Table 7 summarizes the basic features of positivism, interpretivism, and pragmatism paradigms.

Table 7: *Positivism, Interpretivism, and Pragmatism paradigms*

Paradigm	Research approach	Ontology	Axiology	Research strategy
Positivism	Deductive	Objective	Value-free	Quantitative
Interpretivism	Inductive	Subjective	Biased	Qualitative
Pragmatism	Deductive/Inductive	Objective or subjective	Value-free/biased	Qualitative and/or quantitative

Source. Wilson (2010)

Table 7 above depicts that this paradigm encompasses three main aspects: ontology, which examines existence; epistemology, which explores knowledge; and axiology, which delves into value. In summary, pragmatism as a problem-solving methodology involves identifying a problem within a social context and taking appropriate action to resolve it.

3.3.2. The Rationales for Pragmatic Paradigm

The choice of interpretative paradigm as a philosophical ground responded to two factors. Pragmatics "recognize that there are many different ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture, and that there may be multiple realities" (Saunders, Lewis, & Thornhill, 2012).

Within the framework of pragmatism, researchers have the flexibility to select a research design and methodology that best suits the research question under investigation. Pragmatism is often characterized by the use of abductive reasoning, which involves a cyclical movement between deduction and induction. Through this iterative process, researchers actively engage in the creation of data and the development of theories in order to address the research objectives effectively (Goldkuhl, 2012; Morgan, 2007).

Pragmatism, as a paradigm, emphasizes the necessity of using effective techniques to investigate practical challenges, allowing for the use of different sources of information and knowledge to answer research questions (Wahyuni, 2012). As a result, this paradigm lends itself well to mixed methods research, which entails collecting and integrating quantitative and qualitative data within a single study, as well as multimethod research (ukauskas, Vveinhardt, & Andriukaitien, 2018).

3.4. The Rationale for Mixed Methods Research

Mixed methods research (MMR) integrates both quantitative and qualitative methods to enhance the comprehension of research problems, surpassing the limitations of using these methods in isolation (Creswell & Plano Clark, 2007). There are four rationales for combining quantitative and qualitative data within a research study.

1) **Expansion**: The first rationale for utilizing a mixed methods research approach is to broaden the scope of the study. This implies that an MMR approach enables researchers to expand their investigation by obtaining a comprehensive understanding that combines depth (qualitative) and breadth (quantitative) perspectives. The benefits of gathering both structured quantitative data and unstructured qualitative data contribute to a more comprehensive comprehension of a research problem (Creswell, 2003)..
2) **Complementarity**: By employing both data sets, researchers can address the same research question, resulting in increased certainty and broader implications in their conclusions (Maxwell, 2016; Morgan, 2014). In essence, the combination of two methods aids in constructing a comprehensive and holistic understanding (Teddlie & Tashakkori, 2009). Additionally, it offers an opportunity to incorporate a diverse range of contrasting or complementary perspectives, which are valuable as they not only foster additional reflection and enhance our understanding of a phenomenon but also pave the way for future investigations (Teddlie & Tashakkori, 2009).
3) **Increasing Rigor**: The MMR approach enhances to provide results that are more dependable since the advantages of the qualitative methods balance the disadvantages of the quantitative methods and vice versa. In order to combine two sets of strengths while simultaneously making up for each method's shortcomings, the two approaches can be combined (Plano Clark & Ivankova, 2016).
4) **Triangulation**: Data triangulation in a mixed-methods study is generally accepted as a strategy for validating results obtained with the individual method (Bergman, 2008). In other words, gathering various types of data provides valuable insights into a phenomenon that cannot be attained through individual methods alone. This

comprehensive approach generates more valid and robust inferences compared to relying on a single method (Teddle & Tashakori, 2009). As a result, data triangulation contributes to the establishment of a well-validated conclusion and enhances the credibility of inferences derived from a specific approach (Ventakesh, Brown, & Bala, 2013).

3.5. Case Study as a Research Strategy

Research strategy, according to Saunders et al. (2009), "is the general plan of how the researcher will go about answering the research questions" (p. 600). This definition revealed that research strategy refers to how researchers propose to answer research questions and implement the methodology. Yin (2003) recommended three conditions for selecting a particular research strategy in the same context. First, "the type of research question." Second, "the extent of control an investigator has over actual behavioural events." The third condition is "the degree of focus on contemporary or historical events" (p. 5).

In light of the aforementioned conditions, this case study exemplifies the research strategy employed to address the research questions at hand. Importantly, the researcher refrained from manipulating the meaning(s) through experimentation or quantitative measurement. Instead, this deliberate choice aimed to foster a deeper comprehension of the phenomenon being studied within its authentic context.

This inquiry applied the case study as a research strategy. As a qualitative methodology, a case study refers to "an exploration of a time- and space-bound phenomenon" (Alpi & Evans, 2019, p.2). Stake (2000) described a case study as the investigation of a "bounded system" (p. 436). According to Creswell (2002), the word "bounded" indicates that "the case is separated out

for research in terms of time, place, or some physical boundaries" (p. 485). In other words, it is essential to establish boundaries around the subject under investigation (Merriam, 1998).

Accordingly, Creswell (2002) defined a case study as "an in-depth exploration of a bounded system (e.g., an activity, event, process, or individuals) based on extensive data collection" (p. 485). In this context, a bounded system could be an activity, an event, a process, or a group of individuals (Creswell, 2002, p.485). Therefore, delimiting the "boundaries" of a case (bounded system) is an essential step. Then, it reveals that qualitative researchers need to set boundaries that adequately surround a bounded system (a case) in terms of the settings (time and place) (Creswell, 2014, p.14; McMillan and Schumacher, 2001).

Furthermore, using multiple methods for gathering and analyzing data is a prominent feature of the case study strategy (Merriam, 1998, p. 28). For instance, a qualitative researcher may use observation, interviews, and documents to collect data. For this purpose, an investigator could use one or several data collection methods to generate an in-depth and sharpened understanding of a contemporary phenomenon (Collis & Hussey, 2009; Creswell, 2013; 2016; Crowe, Cresswell, Robertson, Huby, & Sheikh, 2011).

3.5.1. The Rationales for Case Study

Principally, Anderson (1993) described case studies as a strategy that aims not to study the entire organization. Instead, a case study focuses on a specific geographic area or a limited number of persons. In this light, Noor (2008) considered a case study appropriate when the problem needs a deep consideration of a few events or conditions and their linkages. Therefore, the researcher addressed the following concerns using the case study strategy.

a) Compatibility with the Research Aim

However, statistical generalizations to the broader population in qualitative research are not the main focus. Instead, the primary purpose is to generate a rich, contextualized understanding of some aspect of human experience by studying specific cases in-depth (Polit & Beck, 2010). In the case studies, a researcher has little influence over the events as they develop in the real-life context. Hence, there is no possibility of manipulating the research variables to investigate social phenomena (Yin, 2009). In light of this view, this qualitative research focused on the meaning through understanding visually impaired learners' experiences to get insights and interpretations qualitatively.

b) Compatibility with the Philosophical Underpinnings

Understanding a research philosophy is essential for understanding how an inquirer conducts a study (Wilson, 2014). In this light, this research was congruent with pragmatism as a philosophical orientation that guided this inquiry process. The focus of this paradigm is not to pre-define independent and dependent variables. Instead, the emphasis is on how a situation or an issue emerges through a holistic approach to human sense-making (Kaplan & Maxwell, 1994). Consequently, Stake (1995) stresses that case study research is anchored in particularization rather than generalization. Therefore, the purpose of this study was not to produce outcomes for a larger group of people but to generate an in-depth understanding of the phenomenon of interest.

3.5.2. Multiple Case Study Design

Yin (2003) categorizes explanatory, exploratory, and descriptive as the three types of case studies based on research objectives. An explanatory case study is typically used to test primary causal associations or relationships, in which a researcher mainly uses this type for theory testing (Baskarada, 2014, p.4). In exploratory case studies, an investigator explores

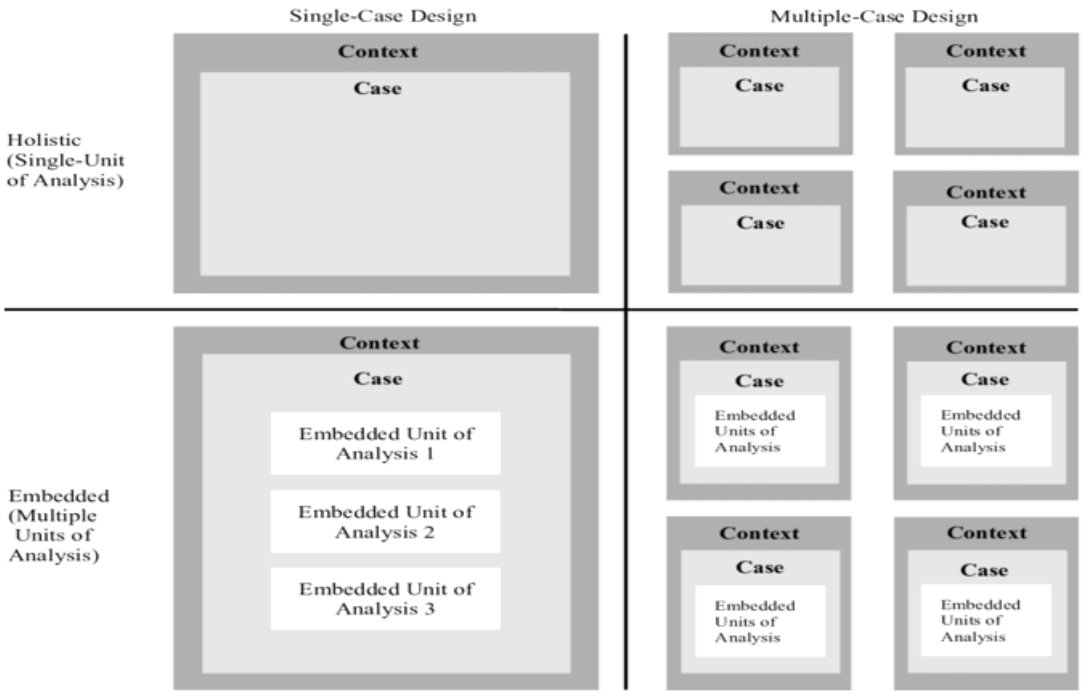
situations where the intervention (the case) has no clear or single set of outcomes (Yin, 2003). For Baskarada (2014), exploratory case studies are familiar with prior research or little theory. Therefore, an inquirer could use this type for theory building (p. 4).

This study uses multiple-case studies to collect different data from bounded systems (or cases). Then, every case in a multiple-case study, according to Stake (2013), is a distinct entity. For Heale and Twycross (2018), a multiple-case study enables a thorough and comprehensive comprehension of the cases as a cohesive unit. This approach facilitates an in-depth understanding of the cases by examining their shared characteristics and unique variation (p.7).

Accordingly, the intent of using multiple-case studies was to explore the phenomena under investigation using a replication strategy. In simple terms, collective case studies aim to replicate insights obtained within individual cases or clarify contrasting situations (Yin, 2003). Yin (1994) delineated two stages of the replication strategy. First is a "literal replication" stage, in which a scientist selects cases (as far as possible) to gain similar findings. The second is a "theoretical replication" phase, where an investigator explores and confirms or disproves the patterns identified in the initial cases. Hence, this strategy can illustrate whether the results are valuable or not (Eisenhardt, 1991).

Furthermore, Yin (2014) recommended that it is essential to clarify whether it consists of a single unit of analysis (a holistic) or multiple units of analysis (an embedded) (Yin, 2014, p. 50). Interestingly, Thus, according to Creswell (2014), "the unit of analysis in the case study might be multiple cases (a multisite study) or a single case (a within-site case study)" (as cited in (Alpi & Evans, 2019, p. 2). In simple terms, an individual, a group, or even an entire community, for instance, would be examples of units of analysis. Figure 8 illustrates the basic types of case study designs.

Figure 8: *Basic Types of Designs for Case Studies*



Source. Yin (2014, p. 50).

Yin (2003) distinguished between *holistic* case studies, where an investigator studies a case as a whole. On the other hand, an *embedded* case study consists of more than one sub-unit of analysis. In simple terms, this type consists of smaller sub-case studies within a case (Yin, 2003). Defining a study of two cases as holistic or embedded depends on what an investigator defines as the context and research goals (Runeson & Höst, 2009, p. 139).

In this study, there were two contexts: (a) inclusive education for visually impaired students where they learned with their non-visually impaired peers. In contrast, (b) special education was the second context where visually impaired pupils studied only with their visually impaired peers. Accordingly, this research used the embedded design whereby El-Oued

University and Robbah School for SVI represented the two multiple cases for this study. Besides, both visually impaired students represented a unique unit of analysis in each case study.

3.6. Participants and Research Setting

3.6.1. Population

Kabir (2016) described the concept of population as "the total of items about which information is desired" (p.169). This definition agrees with Polit and Beck, who stated that the population is an entire set of individuals having specific characteristics (2006, p. 506). Under this view, a sample "is part of the population that represents the characteristics of the population" (Kabir, 2016, p.169). Thus, a sample is a subset of the population for measurement (Banerjee & Chaudhury, 2010).

Furthermore, population sampling "is the process of selecting the sample for estimating the population characteristics" (Kabir, 2016, p.169). In other words, sampling involves selecting only a particular part of the population of a study to obtain information about an entire population. Bless and Higson-Smith (as cited in De Vos, 2002) referred to the term "population" as the whole group of objects that the researcher aims to generalize those sample findings.

In this study, there were two target populations. The first was all the visually impaired pupils at Robbah School for SVI who were pupils in the stage of middle school. The second population consisted of all the students with visual impairment who were enrolled at EL-Oued University. The two populations were chosen because of their accessibility.

3.6.2. Sampling

Sampling entails selecting and studying a small subset from a larger group, with the assumption that the sample represents the same type of individuals as in the overall population. Simply put, sampling involves choosing a specific number of study units from a defined

population (Bhardwaj, 2019). There are two main types of sampling: probability sampling and nonprobability sampling (Bailey, 1994; Levy & Lemeshow, 1999; Robson, 2002). In probability sampling, the selection probability of each participant is known. On the other hand, in nonprobability sampling, the interviewer lacks knowledge about the probability of selecting a person from the population (Wilson, 2014). The various types of sampling and their respective techniques are illustrated in Table 8 below.

Table 8: *Techniques of Non-Probability and Probability Sampling*

Types of sampling	**Characterized by**
Nonprobability sampling	**Subjects selected by the researcher**
1. Convenience	A group already formed and easy to use
2. Purposeful	Knowledgeable and available persons
3. Snowball	Selected respondents suggest other respondents
4. Quota	Stratified sampling, but not randomly chosen
Probability sampling	**Subjects selected by a random mechanism**
1. Simple random	Pull names out of a hat
2. Systematic random	Computer generated numbers to select
3. Stratified	The sample divided into groups called strata
4. Cluster	Groups of strata

Source. Griffee (2012, p. 58)

3.6.2.1. Stratified Random Sampling

The researcher employed stratified random sampling as the chosen sampling technique. Stratified sampling is a probability-based approach where the population is divided into distinct subgroups or strata, and subjects are then randomly selected from each stratum in proportion to their representation in the population (Parsons, 2014). In stratified sampling, two methods can be used to allocate samples from the strata: proportional allocation and equal allocation. Proportional stratified sampling ensures that the identified subgroups in the sample are represented in the same proportion as they exist in the population. In contrast, equal stratified sampling ensures an equal representation of subgroups within the sample (Alvi, 2016).

3.6.2.2. Sample Size

- **A Minimum Sample Size for Research Design**

Table 9: *Minimum Sample Size for Quantitative and Qualitative Research Designs*

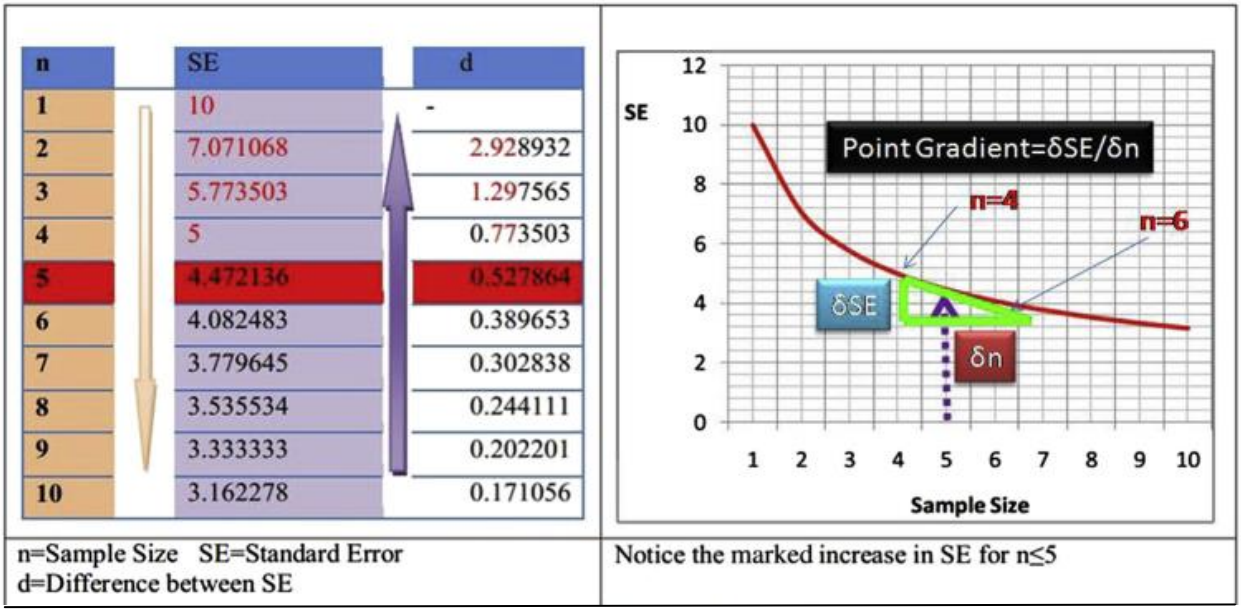
Research Design/Method	Minimum Sample Size Suggestion
Correlational	64 participants for one-tailed hypotheses; 82 participants for two-tailed hypotheses (Onwuegbuzie et al., 2004)
Causal-Comparative	51 participants per group for one-tailed hypotheses; 64 participants for two-tailed hypotheses (Onwuegbuzie et al., 2004)
Experimental	21 participants per group for one-tailed hypotheses (Onwuegbuzie et al., 2004)
Case Study	3-5 participants (Creswell, 2002)
Phenomenological	≤ 10 interviews (Creswell, 1998); ≥ 6 (Morse, 1994)
Grounded Theory	15-20 (Creswell, 2002); 20-30 (Creswell, 2007)
Ethnography	1 cultural group (Creswell, 2002); 30-50 interviews (Morse, 1994)
Ethological	100-200 units of observation (Morse, 1994)

Source. Onwuegbuzie and Collins (2007, p. 289).

Table 9 clarifies these suggestions. Five independent participants in a group are the minimum tolerable quantity, according to Abu-Zidan, Abbas, and Hefny (2012), who made this suggestion based on their "experience." For Patterson, Weaver, Clark, and Yealy (2010), five cases should be the "lowest advised" number in a case series.

When dealing with a considerable number of subjects, the standard error of the mean (SEM) used for comparisons becomes substantially greater. The SEM is determined by dividing the standard deviation (SD) by the square root of the sample size (Esene, Kotb, & ElHusseiny, 2014, p. 661). Figure 9 clarifies statistical proof of this situation.

Figure 9: *Statistical Proof of Sample Size for Case Reports.*

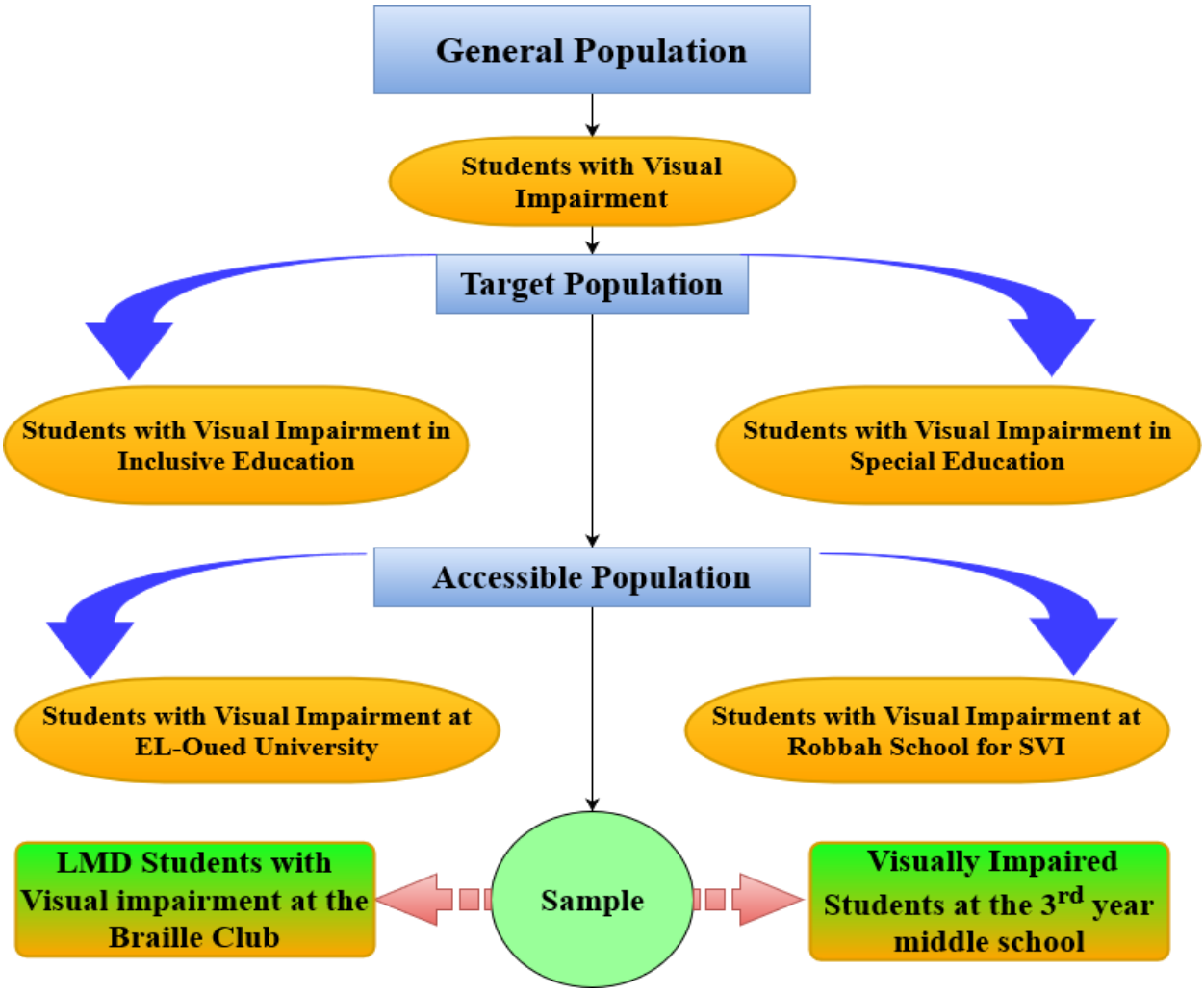


Source. Esene et al (2014, p. 662).

A larger standard error (SE) corresponds to a wider confidence interval, indicating lower precision of the effect size and potentially yielding statistically insignificant P-values. However, a cutoff of 5 is considered appropriate when reporting individual cases or case reports. Beyond this cutoff, data can be combined and summarized to include a larger number of subjects (Esene et al., 2014, p. 661).

As an illustration, Figure 10 clarifies that the general population was all students with visual impairment. Accordingly, the target population was all visually impaired students at inclusive and special educational institutions. The accessible population was all the VI pupils at Robbah School for SVI and EL-Oued University. Therefore, on the one hand, this stratified sampling consisted of one sample of LMD students with visual impairment from the Braille Club at EL-Oued University. On the other hand, the second sample included the visually impaired pupils in the third year of middle school at Robbah School for SVI.

Figure 10*: An Illustration of the Stratified Sampling Strategy Used for this Study.*



Note. LMD is an acronym that stands for License-Master-Doctorate.

➢ **Determination of Sample Size for Research Design**

The researcher used the Taro Yamane statistical formula to determine the number of samples from the population in this study. This formula is:

$$n = \frac{N}{1 + Ne^2}$$

Where; n = the sample size

N = the finite population

e = the level of significance or limit of tolerable error

1 = unit or a constant

Therefore, the sample size is calculated as follows:

$$n = \frac{6}{[1 + (6)(0.05)^2]} = \frac{6}{1.015} = 5.91 \approx 6$$

Therefore, the sample size was 6 participants from each case (VIS of the Braille Club and the SVI of the 3rd year of middle school).

3.6.2.3. Research Sites

The researcher has conducted this study in two different educational contexts for SVI education in El-Oued province in Algeria.

a) **El-Oued University:** Echahid Hamma Lakhdar University, formerly known as EL-Oued University, is a publicly funded institution of higher education. It has been officially recognized by the Algerian Ministry of Higher Education and Scientific Research since 2001. It is located in the northeast of El-Oued city. However, there are various colleges at the University of El-Oued. All visually impaired learners who participated in this research were enrolled in Social Sciences and Humanities faculties.

b) **Robbah School for SVI:** is currently the first and only educational institution in El-Oued city where VI pupils learn exclusively with their VI peers. Interestingly, the Algerian Ministry of National Solidarity, Family and Women's Issues has recognized this school as a non-profit school that provides a full continuum of services, including a residential campus for visually impaired learners. This school currently consists of the primary and middle school levels. Interestingly, this school adopts the same curriculum the Ministry of National Education prepared for teaching non-visually (non-sighted) pupils.

3.7. Methods and Procedures of Data Collection

According to Kabir (2016), data collection "is a systematic process of gathering and measuring data on variables of interest" (p. 202). Thus, a researcher could answer specific research questions. In their study, Johnson and Christensen (2012) pointed out that researchers could use more than one gathering data tool for conducting a case study. Accordingly, this study employed two essential tools for collecting data. On the one hand, qualitative observation represented a secondary instrument. On the other hand, an in-depth qualitative interview represented the primary data collection tool. The following description explains what, why, and how the researcher used these two data collection methods.

3.7.1. Pilot Study Procedures

A preliminary study (pilot study) aimed to test data collection methods and procedures. (Gall, Gall & Borg, 2007). Accordingly, the researcher could practice the data collection tools of this investigation before undertaking the actual research. Thus, investigators become familiar with these tools before conducting the examination (Drew, Hardman & Hosp, 2008). From this view, Yin (2009) recommended the use of pilot studies as a technique "to develop relevant lines of questions" before the initiation of the actual research and to facilitate the refinement of data-gathering plans and procedures (Yin, p. 92).

In the current study, using a pilot study played an essential role in formulating questions in the interview guide. In this way, piloting the interview questions could support the flexibility of the semi-structured qualitative interview method. Consequently, the researcher reformulated ambiguous questions. Then, the interviewer performed the required revisions to the interview guide to ensure that the data accurately addressed the study questions.

3.7.2. Qualitative Interview

The qualitative interview is a dominant method used for gathering consistent qualitative data. This type of interview captures rich and descriptive data about a participant's thoughts, beliefs, and knowledge about a topic (Johnson & Christensen, 2019). For this purpose, the interviewer asks the respondents a set of oral questions (Gall et al., 2007). Furthermore, the interview instrument is a way of gaining an in-depth understanding of an interviewee's story. From this view, phenomenology study mainly uses interviews, in which a researcher highlights the individual participant's lived experience (Seidman, 2006).

3.7.2.1. Semi-Structured Interview

The researcher employed a semi-structured interview. It involves open-ended, closed-ended, and probing questions to gain rich information from research participants (Gall et al., 2007). Moreover, it could be possible to make follow-up answers because respondents could immediately clarify ambiguous statements or meaning through additional open-ended questions, i.e., probing questions (Ary et al., 2010; Gall et al., 2007). Then the validity of reports increased substantially (Gay et al., 2009).

3.7.2.2. The Rationales for the Interview

Qualitative interviewing enables a researcher to delve into the inner world of another individual and gain a comprehensive understanding of their perspectiv (Patton, 1987). According to Kvale (1996), a qualitative interview "attempts to understand the world from the subject's point of view, unfold the meaning of people's experiences, and uncover their lived world before scientific explanations." This view revealed the main advantages of the interview method. First, it directly contacts the subject under study and the researcher. Second, the interview is an effective tool for obtaining detailed information. Third, the exploration of the lived experience of participants firsthand without manipulation (Genise, 2002; Shneiderman & Plaisant, 2005).

Furthermore, Hitchcock and Huges (1989) argue that semi-structured interviews “allow depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the interviewee’s responses” (p. 83). Under this statement, Kaufman (1994) clarifies that an “open-ended” format of semi-structured interview questions allows the researcher to explore and deepen the response to the question through probing questions (p. 125). Thus, this technique could increase the richness of the information obtained.

Cohen (2000) defines an interview as a two-way conversation initiated by the interviewer to gather pertinent research data and concentrate on a topic guided by research objectives such as systematic description, prediction, or explanation (p. 269). Similarly, scholars like Bell (1987), Berg (2007), and Kvale (1996) suggest utilizing interviews as a social research tool to obtain "direct" explanations for human actions through comprehensive verbal interactions (Alshenqeeti, 2014).

3.7.2.3. Interview Procedures

The procedures of undertaking semi-structured interviews involved three significant phases. The elaborations of steps of each stage were as the following points.

a) Pre-Interview Phase

First, the interviewer (the researcher) organized the schedule and setting for interviewing the participants. In other words, the investigator determined the interview sessions’ dates, times, and sites with the target respondents. Second, the interviewer commenced through greetings and then self-introduction to establish a rapport that could aid and support interviewees to communicate willingly. Third, before starting each interview, the interviewer clarified the research purpose and the potential duration of the discussions for each interview session. Finally, the researcher read aloud the informed consent instructions to each participant. Because of their

visual impairment, the researcher requested only their oral permission. (Appendix I). The researcher provided read orally the informed consent form translated into Arabic (Appendix J).

b) During the Interview Phase

In this phase, the researcher used the interview protocol in sequence using the probing questions technique to elicit rich data and in-depth descriptions. The interview protocol contained ten (10) open-ended questions (items). The interviewer used Rogers' Innovation Diffusion Theory as a theoretical framework to elicit data and frame the interview process into a systematic guide. Thus, the researcher arranged the interview items into six key sections (Appendix K):

1) Demographic information
2) Compatibility of Assistive Technology
3) Observability of Assistive Technolgy
4) Complexity of Assistive Technology
5) Trialability of Assistive Technology
6) Relative advantages of Assistive technology

Furthermore, the duration of each interview session ranged approximately from 35 minutes to 45 minutes. The researcher asked the interviewees for any additional questions, suggestions, or comments at the end of the interviews. Finally, the interviewer expressed gratitude and pleasure to the interviewees for their valuable contributions.

c) Post-Interview Phase

First, the researcher translated the audio-recorded from Arabic to English transcriptions. In this research, the inquirer transcribed verbatim, coded, and themed the interview data. Then, the interviewer identified themes and coded data into three stages: (1) The generating initial

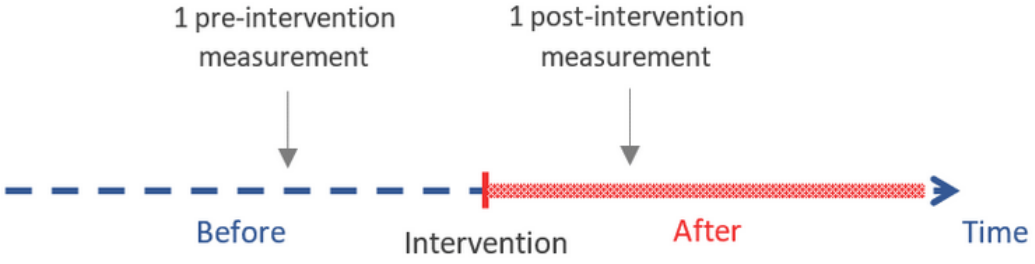
codes stage. (2) The axial coding stage supported the researcher in revising the thematic categorization for further improvement. (3) The third stage was selective coding. The interviewer coded the data systematically and categorized them into different sections.

3.7.3. A Quasi-Experiment

A quasi-experiment is a method that compares two groups in which one is given the treatment, and the other is not. As Sabarwal and White (2014) said, the quasi-experimental identifies a comparison group that is possible to level with the group that is given treatment in terms of initial characteristics. Besides, a quasi-experimental design is a non-randomized study design used to evaluate the effect of an intervention despite a lack of 'randomization.' For example, the intervention can be a training program.

However, the researcher could not identify a large sample to split into control and experimental groups. The investigator used a one-group pre- and post-tests design (Figure 11). In this case, there was no control group to compare with the experimental group. This type of experimental design was chosen because the visually impaired students population was very small.

Figure 11: *One Group Pre- and Post-Tests Intervention*



3.7.3.1. Research Instrument

The instrument is the tool chosen and used by the researcher to collect the data. The instrument of the current research was a test of reading speed. The researcher measured each participant's

average reading speed in words per minute (WPM). In addition, to measure whether the test is valid, the researcher has already consulted the test with the English teacher at Robbah School for SVI, where the researcher did the research.

3.7.3.1.1. Experiment Procedures

The data of this research were obtained from the scores of the pretest and post-test as follows:

1. Pre-test Phase

This test has given to know the basic competence for SVI in reading English when they read a text using printed Braille paper through the following steps:

- The researcher provided each visually impaired student (individually) a text in Braille format.
- The students read the text out loud.
- The researcher measured the reading speeds of participants.
- The investigator determined the difference score of each sample, and the result from the pretest for each of the samples was calculated.

1. Intervention

After the researcher calculated the score, the intervention phase was started. The inquirer introduced an electronic Braille display for three intervention meetings for each sample. The reason behind this step was that the most crucial factor in reading for speed was to make VI learners familiar with this material as an adaption of reading assistive technology device.

i. First Meeting

- **Pre-Activity: Training Stage** (10 minutes)
  - The researcher greeted the students.
  - The researcher explained to students how to apply an electronic Braille display as a strategy for the reading English activity.

- The researcher reminded the participant not to hesitate for any further explanations.

B) Second Meeting

- **During-Activity: Using Stage** (20 minutes)
  - The investigator greeted the students.
  - The researcher gave each student the same reading task that included ten isolated words.
  - The researcher asked VI learners to spell and pronounce these vocabularies.
  - The researcher made an evaluation.

C) Third Meeting

- **Post-Activity: Feedback Stage** (20 minutes)
  - The researcher greeted students.
  - The researcher reviewed the process of the reading activity.
  - The investigator explained the meaning of some vocabularies that learners asked for further clarification.
  - The researcher gave feedback.

2. Post-test Phase

This test aims to measure VI students' speed-reading rates after using an electronic Braille display (intervention).

- The researcher provided each visually impaired student (individually) with the text in Braille format using an electronic Braille display.
- The students read the text out loud.
- If a word could not be read, they were instructed to say 'Pass' so that the investigator could calculate the rates of words that participants read.

- The researcher measured the reading speeds of participants.
- The investigator determined the difference score of each sample, and the result from the post-test in every sample was calculated.

3.8. Procedures of Data Analysis

3.8.1. Qualitative Data Analysis

3.8.1.1. Thematic Analysis

Data analysis involves breaking down a phenomenon into its basic components to gain a better understanding (Mouton & Marais, 1991),. In this study, the researcher used thematic analysis as a qualitative method. The objective was to examine categories and identify data-related themes or patterns. Thorough details were provided, and interpretation was employed to address various concerns (Boyatzis, 1998, cited in Alhojailan, 2012, p. 12).

Thematic analysis was used to analyze qualitative data in this research. It involves identifying and analyzing patterns or themes within the data (Braun & Clarke, 2006). The goal was to uncover and define these themes (Maguire & Delahunt, 2017). A theme refers to a recurring pattern or significant interpretation (Braun & Clarke, 2006, p. 82). Maguire and Delahunt (2017) highlighted that themes emerge from the data and are directly related to the research question, representing noteworthy or interesting patterns within the collected information (p. 3353).

In the same context, there are two approaches to conducting thematic analysis. Researchers could employ an inductive or deductive approach to theme identification (Braun & Clarke, 2006; 2012). In the inductive approach, the focus is on developing a theory such as grounded theory. This approach generates themes from the available data (Varpio, Paradis, Uijtdehaage, & Young., 2019). Conversely, the deductive approach uses a framework or an

existing theory to identify themes of interest (Braun & Clarke, 2012; Varpio et al., 2019). Therefore, an inductive approach tends to provide a broader analysis of the entire body of data. In contrast, a deductive approach highlights a particular aspect of the data that could be best illuminated or understood in the context of existing knowledge or frame (Braun & Clarke, 2014).

This method "aims to explore the understanding of an issue or the signification of an idea" (Attride-Stirling, 2001, p. 387). The thematic analysis process allows for greater flexibility in data analysis, gives a framework for organizing topics, and guides the study topic's interpretation. (Braun & Clarke, 2014). Furthermore, thematic analysis allows recording and arranging data into meaningful patterns that answer your research objectives. (Braun & Clarke, 2008).

3.8.1.2. Procedures of Thematic Analysis

a) Phase One: "Familiarization with Data"

This phase involved "repeated reading of the data, and actively reading the data, searching for meanings, patterns, and so on." (Braun & Clarke, 2006, p. 87). Accordingly, this phase consisted of three steps. First, the researcher transcribed the verbal data of each respondent's interview sessions into written texts. The second step was reading the entire data set. In the third step, the researcher re-read these transcripts (at least twice). The aim was to identify meaning and patterns throughout the participants' interview transcripts

b) Phase Two: "Generating Initial Codes"

During this phase, the focus was on "coding the interesting features of the data systematically across the entire data set, collating data relevant to each code" (Braun & Clarke, 2006, p. 87). This phase then focused on reducing the data and producing initial codes (Attride-Stirling, 2001; Braun & Clarke, 2014). This phase focuses on developing potential themes by

generating an initial code set. For this purpose, the data was coded into "meaningful and manageable chunks of text, such as passages, quotations, single words…" (Attride-Stirling, 2001, p. 391). This view means highlighting portions of the text and applying labels and codes describing the content's nature.

c) Phase Three*: *"Searching for Themes"

At this phase, the concern was "sorting the different codes into potential themes, and collating all the relevant coded data extracts within the identified themes" (Braun & Clarke, 2006, p. 89). Themes do not simply emerge from the data (Varpio et al., 2017). Instead, the researcher constructed themes by analyzing, combining, comparing, and even graphically mapping how codes relate to one another.

This process required semantic and latent thematic analysis levels (Braun & Clarke, 2013). Firstly, the researcher conducted the semantic level thematic analysis through inductive analysis to find out the "explicit or the surface meanings of the data" (Braun, & Clarke, 2006, p. 13). Secondly, the investigator conducted the latent (interpretative) level analysis that "goes beyond the semantic content of the data, and starts to identify or examine the underlying ideas, assumptions and conceptualizations" (Braun, & Clarke, 2006, p. 13).

The researcher determined the potential themes by comparing the emerging themes across the data extracts. Then, the inquirer collated all relevant codes from the data extracts within identified themes. This phase represents a draft for developing themes. For this purpose, thematic maps were significant for visually demonstrating cross-connections between concepts and among main themes and subthemes (Braun & Clarke, 2012).

d) Phase Four: "Reviewing Themes"

This stage included “checking if the themes work concerning the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis” (Braun & Clarke, 2006, p. 87). This phase contained two levels to refine and check the draft of themes identified in phase three. Level 1 involved reading all the collated extracts to form a coherent pattern for each candidate theme. In level 2, the researcher checked whether the themes were coherent concerning the coding extracts in each case.

Then, the investigator re-examined themes and re-coded additional data that would fall under the themes that have been newly created or modified in this phase. Next, the researcher read through the entire data set to ensure that the generated themes accurately and relevantly represented the data of the coded extracts. By finishing this process, the researcher generated a candidate thematic map of the analysis.

e) Phase Five: “Defining and Naming Themes”

After refining the thematic map, the researcher created a definition and narrative description of each theme. Braun and Clarke (2006) stated that “by ‘define and refine’, we mean identifying the ‘essence’ of what each theme is about (as well as the themes overall), and determining what aspect of the data each theme captures” (p. 92). The goal of this phase was to “…clearly define what your themes are and what they are not” (Braun & Clarke, 2006, p. 92).

Braun and Clarke (2012) viewed that “data don’t speak ‘for themselves’ – you mustn’t simply paraphrase the content of the data. Your analytic narrative needs to tell the reader what about an extract is interesting, and why” (p. 10). The investigator selected extracts to analyze and then set out the ‘story’ of each theme to achieve this goal. In other words, the researcher focused on defining each theme, identifying the theme’s essence (the story), and determining what aspect of the data and research questions the theme fits under (Braun & Clarke, 2014).

f) Phase six: "Producing the Report"

This final step involved writing the final analysis and description of the findings (Braun & Clarke, 2013). This phase focuses on analyzing the data in narrative form that "goes beyond the description of the data, and make an argument concerning your research questions" (Braun & Clarke, 2006, p. 93). Therefore, an analyst should include the following steps. a) Selecting exceptionally vivid extracts that capture the essence of the point, b) conducting a final analysis of selected extracts, c) relating the analysis to the research question (s), and d) producing the analysis' final report are all required steps in this process (Braun & Clarke, 2006, p. 87).

Procedures of Quantitative Data Analysis

The researcher used two forms of two-tailed *t*-tests based on analyzing Pretest and post-test scores. The t-test is a parametric test used to compare two small sets of quantitative data when the sample size is less than 30 ($n < 30$). The t-test assumes that the two samples arise from the same normally distributed population with unknown variance. Therefore, the investigator ran the Shapiro-Wilk test using SPSS to examine if a variable is normally distributed in a population. The Shapiro-Wilk W statistic can only be computed when the sample size ranges from 3 to 5000 (Royston, 1995; Shapiro & Wilk, 1965).

3.8.2. Quantitative Data Analysis

3.8.2.1. Within Groups Comparison: Paired T-Test

For testing the present research's first and second non-directional hypotheses (H01 and H02). The test statistics are given by:

$$t = \frac{\bar{d} - 0}{s_D/\sqrt{n}}$$

Where $\bar{d}$ is the sample mean of d_i and s_D is the sample standard deviation of d_i (Kim, Park, & Wang, 2018).

A paired t-test (also referred to as a dependent or correlated t-test) is a statistical test that analyzes the averages/means and standard deviations of two groups that are correlated to see if there is a difference of statistical significance between them. The groups in this exam are related because they are made up of the same people, have the same item, or are subjected to the same conditions. When the same item or group is tested twice, the paired t-test is performed. As a result, it produces paired observations. Shier (2004) and Kim et al. (2018).

3.8.2.2. Between Groups Comparison: Independent T-Test

In a between-subjects design, the independent t-test is employed when there are two distinct groups of persons or cases. An independent samples t-test analyzes the means of both sets of data to find out whether there is a significant difference in mean observations across the two samples. When the sample sizes are the same, the following formula may be used:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

In this test, $\bar{x}_1$ and $\bar{x}_2$ denote the observed sample means for both samples, n_1 and n_2 refers to the sample size of both sample, S_1 and S_2 means the standard deviation of each sample.

The investigator calculated the *t*-value by hand. Then, the researcher used SPSS to calculate the statistical significance value (p-value) at the 5% significance level ($\alpha = 0.05$). The SPSS reported this value in the column labeled: "Sig (2-tailed)" rather than labeling it "*p*." Then, the researcher made decisions regarding the stated hypotheses of this research based on the statistical evidence of the pretest and post-test analysis.

3.9. Trustworthiness of Data

In their book entitled *Naturalistic Inquiry*, Lincoln and Guba (1985) posited that *trustworthiness* is the truth value of the study's findings. Ensuring trustworthiness was an essential criterion for increasing the quality of qualitative research. In other words, the quality of this research study depended on achieving a high degree of accuracy and truthfulness of research findings. According to Olivia (2017), trustworthiness addresses how qualitative researchers ensure that the research findings are credible, transferable, confirmable, and dependable.

Trustworthiness indicates the degree of confidence and trust in research results, methods used, and the researcher's interpretation to ensure the quality of a research study (Pilot & Beck, 2014). This concept indicated how a researcher (an inquirer) could persuade readers (the audience) that a high-quality study. Thus, the obtained researcher's findings would be worth interest and value. For this purpose, Lincoln and Guba (1985) developed four criteria for establishing trustworthiness. They are "credibility," "transferability," "dependability," and "confirmability."

a) Credibility

Credibility relates to the degree of confidence in the truthfulness of a research study. Therefore, the degree of trust in research findings (Polit & Beck, 2014). In this context, credibility could determine whether the results are true and accurate and whether the research is reliable and genuine. Marshall and Rossman (1995) regarded credibility as the most critical criterion of *trustworthiness*. The researchers defined this concept as a "manner to ensure that participants were identified and described for the study to show that the inquiry is credible to the constructors of the original multiple realities" (p. 143). From this perspective, researchers would

accurately identify and describe the research participants. Hence, they could enhance the degree of their research credibility.

b) Transferability

The term "Transferability" refers to applying one set of findings to another context (Marshall & Rossman, 1995, p. 143). From this point of view, transferability relates to how an investigator could prove that a study's results would be expected to apply to other settings. Interestingly, "other context" relates to identical phenomena, populations, and procedures in this perspective (Marshall & Rossman, 1995). By this explanation, Streubert and Carpenter (1995) regarded transferability as demonstrating the probability that the research findings have meaning to others in similar situations (p. 318). Consequently, readers could assess how relevant the facts are to their surroundings.

Furthermore, generalizability typically demonstrates that a study's outcomes are applicable only to certain forms of quantitative methods. In contrast, *transferability* doesn't involve broad claims. It allows readers to connect research elements and their experiences (Polit & Beck, 2014).

For this purpose, the researcher provided a detailed description of the settings so that reader could assess the study's transferability. For this reason, the investigator provided descriptive information on the respondents' characteristics. Thus, readers to examine the findings' application to their situation. However, Creswell (2012) states that "In qualitative inquiry is not to generalize to a population, but to develop an in-depth exploration of a central phenomenon" (p.206). For this study, transferability is not a primary criterion to ensure trustworthiness.

c) Dependability

Dependability is associated with the consistency of the research results because it determines how findings are consistent and repeatable with the raw data an inquirer collected. Furthermore, Polit and Beck (2014) explained that this principle of trustworthiness indicates the stability of a study's data over time and the conditions. Similarly, Lincoln and Guba (1985) insist on the relationship between credibility and dependability. They argued that demonstrating credibility goes some distance in ensuring dependability.

Under this view, demonstrating the dependability benchmark clarifies whether a study could yield the accuracy of the same results if a researcher repeated the same research methodology (Mason, 1996, p. 24; Merriam, 1998, p. 205; Babbie, 1998, p. 129).

d) Confirmability

According to Liamputtong (1999), confirmability is the extent to which findings are determined by the respondents of the inquiry rather than the inquirer's biases, motivations, interests, or viewpoints. Confirmability demonstrates that outcomes and interpretations of a study depend on evidence rather than the investigator's or researcher's imagination. As a result, dependability aims to ensure that research outcomes, as far as possible, are the consequence of the informants' experiences and thoughts rather than the researcher's preferences.

3.9.1. Strategies for ensuring the trustworthiness of data

a) The Audit Trail

Consequently, implementing audit trails could enable an auditor to audit the research path related to the methodological and analytical decisions. Then, other researchers could confirm the obtained research findings. Per this view, Shenton (2004) emphasized that using the audit trail "allows any observer to trace the course of the research step-by-step via the decisions made and procedures described" (2004, p. 72). This definition revealed that this process would provide

readers with evidence of the critical research methodology decisions. Besides, the significance of the audit procedure yields in enhancing transparency and acceptability (Akkerman, Bronkhorst, & Zitter, 2013) and improving the quality of small-scale studies(Den Brok, Van Eerde, & Hajer, 2010).

Carcray (2009) states that qualitative studies typically contain much researcher-generated information. Because of this, the author suggests that the key strategy to establish research trustworthiness is through a physical and intellectual research audit trail (Carcray, 2009). For De Kleijn and Van Leeuwen (2018), the audit trail "documents the entire research process including the processes of data gathering and data analysis" (p.2). In simple terms, the audit trail is a clear description and an in-depth illustration of the research process.

b) Thick description

A good researcher's interpretations require thick descriptions (Ponterotto, 2006). The origin of the term "thick description" backs to the work of Clifford Geertz. This researcher introduced this concept in his book *The interpretation of cultures: Selected essays* in 1973. Geertz (1973) considered thick description as a method that allows a qualitative scientist not just to describe a situation but also to add details so that readers understand the significant and complex cultural meanings (Geertz, 1973; Ryle, 1949).

Furthermore, Denzin (1989) determined four essential "thick description" characteristics. The author clarified that "(1) it gives the context of an act; (2) it states the intentions and meanings that organize the action; (3) it traces the evolution and development of the act; (4) it presents the action as a text that can then be interpreted" (p. 33). For Holloway (1997), thick description aims to provide readers with the meaning of the thoughts, perceptions, and emotions that research participants experience (1997, p. 154). With these considerations, Ponterotto (2006,

p. 543) concluded that the thickness of this method comes from the layering of the detailed and rich field observations with the interpretive investigation of participant behaviours.

3.10. Ethical Considerations

Protecting the subjects' human rights under this qualitative investigation was crucial. For this purpose, investigators should consider appropriate ethical principles throughout the research inquiry (Orb, Eisenhauer, Wynaden, 2001). Besides, researchers should tackle diverse ethical considerations (Clegg & Slife, 2009) because they should protect the participants' rights during a study (McMillan & Schumacher, 2010). In light of this, the researcher discussed this study's ethical principles.

- ***Ethical Principle One: Obtaining Permission***

Initially, the inquirer obtained approval from the Head of the Department of English Department at Batna 2 University. Then, the researcher submitted an application for undertaking the data collection process at Robbah School for SVI. It was a written request for gaining the permission of the headmaster of this educational institution. Consequently, his authorization ensured legal approval for conducting this research (Appendix).

- ***Ethical Principle Two: Protecting Confidentiality and Anonymity***

Confidentiality depended on dealing with the respondents' information in the strictest confidence. The researcher assured confidentiality and anonymity for the participant in this study. This ethical principle included removing identifiable information such as their names and geographical cues. This principle focused on establishing trust between the participants and the researcher.

- ***Ethical Principle Three*: *Providing the Right to Voluntary Participation or Withdraw***

In this principle, the researcher informed the respondents that they had the full right to participate and withdraw from this study at any time. This principle invited visually impaired students who initially agreed to participate in this study to have the right to participate voluntarily or refuse to take part in this inquiry. Hence, they could withdraw at any point during this research process. For this reason, the informed consent (Appendix I) form clearly described and assured this right. Besides, this document ensured that withdrawal would not result in any penalty or loss of benefits.

- ***Ethical Principle Four: Obtaining Informed Consent***

The informed consent attempted to offer sufficient information to potential research subjects. However, obtaining the participant's voluntary agreement was more than just an approval with a signature on a form sheet. Instead, this consent document aimed to ensure that the participant subjects understood the research-related information, such as its purpose, benefits, risks, procedures of data collection, and confidentiality.

Moreover, Cox, Kerschbamer, & Neururer (2016) described informed consent as "a series of decisions that take place at pre-identified points as the project unfolds" (p.12). In this context, the researcher adjusted this document's information format in a language the respondents could easily understand its content. As a result, the researcher translated the full consent document written in English into the participants' language (Arabic language).

- ***Ethical Principle Five: Ensuring Data Protection***

This ethical consideration involved two stages for ensuring the privacy of the obtained data. These stages were storing the interview information and transcribing these data. The researcher, as a transcriber, transcribed the data individually in a private room using earphones to avoid the possibility of accessing recordings by other persons.

On the other hand, the researcher stored data in encrypted files on her laptop to ensure adherence to legal requirements. Then, the investigator protected the information stored using a secure password. This procedure was due to the informed consent document that insisted no one other than the researcher, the supervisor, and the co-supervisor could have the right to access the participants' information details.

Chapter Summary

This chapter overviewed this research approach, paradigm, and strategy. Besides, the researcher explained how these methodological decisions guided the process of addressing the research questions of this inquiry. Furthermore, the researcher offered information about the principles for selecting the population, sampling strategy, and sample selection. Moreover, the investigator discussed the procedures for analyzing the collected data by providing insights into the interpretation phases to understand the obtained results better. In addition, the researcher focused on ensuring trustworthiness criteria and addressing ethical considerations in this research. Finally, this chapter concluded with a summary. It briefly demonstrated the overall research methodology for this study.

CHAPTER FOUR: ANALYSIS AND DISCUSSION OF FINDINGS

CHAPTER FOUR: ANALYSIS AND DISCUSSION OF FINDINGS

Introduction

This chapter has two sections reflecting an attempt to report the data collection results. The first section includes the findings of the interviews with visually impaired students from each case study in this research. Additionally, it presents the compilation of results found by applying thematic analysis. The second section contains the pre-test and post-test measurements analysis in light of the theoretical underpinnings used to guide the results.

4.1. Presentation and Analysis of Qualitative Findings

This section starts with the results of the interviews with visually impaired students at EL-Oued university. These findings are followed by the interview results from pupils with a visual impairment from Robbah School for SVI. In the textual data, thematic analysis highlighted prominent themes and sub-themes. The similarities and contrasts between these literary themes and sub-themes were identified. To explain the consequences further, the findings were given in prose form in quote passages. The themes and sub-themes that arose are represented in tabular form below. The exact comments of the participants are in italics.

4.1.1. Results from the Case Study of Braille Club at EL-Oued University

4.1.1.1. Descriptive Demographic Analysis of the Participants

Table 10: *Demographic Characteristics of the Participants at EL-Oued University*

Variable		Total n=5	
		Range	Mean (SD)
Age	Min	21 years	24.17 (1.835)
	Max	26 years	
		Frequency	Percent (%)
Gender	Female	4	66.7
	Male	2	33.3
Visual Impairment Degree	Low vision	2	33.3
	Blind	4	66.7
Visual Impairment Onset	Congenital	2	33.3
	Adventitious	4	66.7
Educational Level	Undergraduate	6	100.0

Table 10 of the demographic data above shows that participants' ages ranged from 21 to 26 years old, with an average of 24.17 years old and a standard deviation of 1.835. Table 11 also shows that participants from EL-Oued University were four females (66.7%) and two males (33.3%). Furthermore, findings depict that 33.3% of participants had low vision while four learners (66.7%) were blind. Two students had congenital vision loss, while four of the participants had acquired visual impairment.

In the same context, results reveal that all the interviewees were students in an inclusive educational setting where they learn with their sighted counterparts at university. That is, all of them were learners in the LMD system (License, Master, and Doctorate) from different social sciences studies, in which five were enrolled in Licence degree while only one student was enrolled in Master degree.

4.1.1.2. Themes Emerged

Four main themes appeared from the data analyses. The first theme was the level of assistive technology type during the TEFL process. In addition, the second theme was the benefit of using assistive technology resources in English learning. The third theme addressed SVI's challenges of using these AT tools for English learning. The fourth theme was SVI evaluation about the impact of AT use in their English class. Table 11 explains the subthemes that provide more details on the main themes.

Table 11: *Themes and Sub-Themes Emerged from EL-Oued University Sample*

Theme 1: Assistive Technology Types Used for EFL Learning
Sub-theme 1: The Availability of Assistive Technology continuum
Theme 2: Purpose for Assistive Technology Use in EFL Learning

Continued

Sub-theme 1: Accessibility to Read Printed Information
Sub-theme 2: Minimizing Over-Dependence on Sighted Students
Sub-theme 3: Sub-Theme 3: Enhancing the EFL Learning Process
Theme 3: Challenges of the Assistive Technology Use for EFL Learning
Subtheme 1: Negative Social Conditioning
Subtheme 2: Lack of Training
Theme 4: Evaluating the Impact of Assistive Technology Use on EFL Learning
Subtheme 2: Improving Self-Efficacy
Subtheme 3: Increasing Self-Esteem

4.1.1.2.1. Theme 1: Assistive Technology Types Used for EFL Learning

In this study, respondents answered the first research question about which tools they used during their English learning process at the level of EL-Oued University. Table 12 below illustrates their answers.

Table 12: *Assistive Technology Tools Used by Respondents of EL-Oued University*

AT Tool	Type	Number of Respondents
Screen Reader	EnVision	2
	TalkBack	6
Digital Voice Recorder	Mobile Recording Application	3
Talking Dictionary	Google Translate Service	3
Braille Equipment	Slate and Stylus	6

Table 12 shows that the Braille slate and stylus is the standard tool used among all the visually impaired students from EL-Oued University. These educational resources are considered low assistive technology because they, as educational materials, are not electronic devices. Furthermore, participants used screen reader software, scanner applications, and talking dictionaries. These devices and applications represent the mid and high levels of the assistive technology continuum.

4.1.1.2.1.1. Sub-Theme 1: The Availability of Assistive Technology Continuum

The following responses clarified that the use of low-tech, mid-tech, and high-tech assistive technology is, to some extent, available for the interviewees. Besides, they used these materials for English learning with different degrees. One participant expressed below:

> *"I write my English lessons using Braille. However, I only use it when I want to write important notes*" (Participant 6).

Another visually impaired student declared:

> *"I use Braille to write the keywords when our English teacher explains the lesson"* (Participant 5).

One of the interviewees pointed out that:

> *"For writing, I use Braille"* (Participant 4).
>
> *"The first tool I use is not my mobile phone. It is the Braille slate and stylus"* (Participant 2).

With the technology revolution, using smartphones has yielded various applications for different services in many fields. In this context, the participants indicated that screen reader software such as Talkback, Envision, and JAWS were the most available assistive technology applications for learning English in higher education. One VI student at EL-Oued University reported that:

> *"There is an application called Envision. It reads everything, whatever the type of language. For example, my smartphone reads aloud my English handouts using this application"* (Participant 1).

Under this view, another visually impaired learner stated:

"I use the 'Envision' application to read any English document for me" (Participant 3).

The same respondent added that:

> *"If I don't understand something during my English lectures. Then, I use my mobile phone. It helps me to explain the meaning of a sentence or translate new words"* (Participant 2).

Interestingly, there was an emphasis by one respondent on the use of a talking dictionary. She said:

> *"When I want to explain some English words, I use Google search service. Next, I write what I am looking for in the search bar by recording my voice. For instance, I write a word in Google translation. This website translates for me that word through voice. Therefore, it allows me to understand the meaning and the pronunciation of that word"* (Participant 1).

Furthermore, another student with a low vision expressed that JAWS is an exciting screen reader for learning English pronunciation. She stated:

> *"My phone allows me to explore words pronunciation using JAWS, and this app dictate any word for me letter by letter"* (Participant 4).

In the same vein, one interviewee stated that:

> *"I record the explanation of my teacher using my mobile phone. Using this way, I can listen to this recording voice as much as I like. If I don't understand something from it. Then, I request my teacher for further clarifications"* (Participant 6).

4.1.1.2.2. Theme 2: Purpose for Assistive Technology Use in English Learning

This theme revealed that listening and reading skills were the most skills that the learners practice in the English learning process. Because of this, they (SVI) agreed that the reason

behind using assistive technology in EFL learning was to enhance the quality of these skills. Moreover, to provide access to visual and auditory content.

4.1.1.2.2.1. Sub-Theme 1: Accessibility to Read Printed Information

This subtheme illustrated that AT provides access to non-visual data such as printed documents for learners with low vision. Thus, SVI would access educational materials in large or standard format using magnifiers apps. For one of the interviewees:

"In English grammar lessons, we, as visually impaired students, cannot comprehend the ideas of figures and diagrams that are used to illustrate the rules. For example, I can't read the content. Thus, using my smartphone helps me somewhat" (Participant 5).

In the same context, another visually impaired interviewee, who is blind, explained that he used Microsoft Word Office software that:

> *"During my English session at the university, I don't write anything because, thanks to Allah, I have a good background in English and grammar in particular. However, I use Microsoft Word office software on my smartphone. It converts the printed English words and texts to digital format. Next, I print the target document in a Braille copy"* (Participant 3).

4.1.1.2.2.2. Sub-Theme 2: Minimizing Over-Dependence on Sighted Students

During the interviews, visually impaired students at EL-Oued University have been found to rely significantly on their sighted counterparts because of the numerous academic obstacles they encounter in learning English as a foreign language. One of the students said:

> *"Because I am not proficient in the English language. Thus, I face difficulties in pronouncing some words. I asked my sighted colleague who could pronounce those*

words for me. Unfortunately, there are usually difficulties in getting help from competent English students. It is hard to depend on one person" (Participant 2).

In the same context, another visually impaired student declared:

"If I miss writing a word while my English teacher explains the lesson, I may ask my classmate for help. If her answer is not precise, I ask my teacher again about that point" (Participant 6).

However, they (interviewees) reported that, to some extent, their English tasks were mainly facilitated by assistive technologies, in which minimizing over-dependence on sighted students was the primary reason for them to use AT to increase their educational achievement in English. Some of these statements by the students include:

"When I use my smartphone in English, I achieve my tasks without any limitations. For example, using a voice recorder allows me to write down in Braille my note and explanation" (Participant 5).

Using assistive technology apps and devices enhanced the listening skills of one of the participants independently, as expressed below:

"…Moreover, using a mobile phone offers options to access information by listening. I can listen many times to the same audio or video. In contrast, there is no available environment for fluent communication in English at our lecture" (Participant 3).

4.1.1.2.2.3. *Sub-Theme 3: Enhancing the EFL Learning Process*

As a result of the shift to online education due to the COVID-19 pandemic, interviewees viewed that using assistive technology resources in learning English made information available and the content of the instructional material more attractive than the traditional resources.

"*When our English teacher shared lessons online teaching platforms during Coronavirus, I could easily access the content. Moreover, using the TalkBack app improved access to this website*" (Participant 1).

4.1.1.2.3. Theme 3: Challenges of the AT Use for English Learning

4.1.1.2.3.1. Sub-theme 1: Negative Social Conditioning

Social conditioning is an essential factor that could affect the attitude of visually impaired students toward assistive technology usage. The participants generally anticipated ignorance regarding their use of assistive technology, particularly in English learning. Some of their comments were as below:

> *"When sighted students notice how I use my mobile phone, they wonder how I do what I do. This situation is something blind people encounter all the time. Unfortunately, some sighted students ridicule how TalkBack reader is used on my phone"* (Participant 4).

This negative attitude highlights some resistance to new technology use by the participants. The following responses are in line with this view.

> *"In our English class, my classmates wondered when I was using the touch-screen of my phone. Some of them were shocked because they expect that I cannot use technology due to my visual impairment"* (Participant 3).
>
> *"My English teacher wonders how I can manage using smartphone apps. Sometimes, he asks me to teach him my method of using them. What's more, they ask me how I can handle hearing this annoying robotic voice! I respond that this is the only available tool to understand what I have learned"* (Participant 6).
>
> *"I think they are about the difference between them and me. However, some of them have a negative view"* (Participant 4).

4.1.1.2.3.2. Sub-theme 2: Lack of Training

Most of this research participants reported difficulties using assistive technology devices and applications because they lacked training on using this kind of educational resource in general and in learning English in particular. They said that they had not adequate support to master the required skills for using assistive technology as quickly as to keep up with teaching and learning. One participant viewed declared that:

> *"I learned to use my phone by myself. However, there are many techniques I couldn't learn. For example, I faced barriers in looking for English information about my lesson available in Braille format. Yet, I didn't know how to find them in digital Braille version like PDF"* (Participant 2).

In the same vein, another participant stated that insufficient knowledge about the use of assistive technology as educational tools as below:

> *"I explored that there are some apps available for visually impaired students, but I didn't know how to use them, especially in English. I didn't find any help to show me how to use YouTube when I was looking for English lectures and lessons explanation. Therefore, I decided to learn it myself"* (Participant 1).

While a visually impaired student from the participants demonstrated that using a TalkBack screen reader was not an easy task to learn without any prior training, her comment below explains this view:

> *"I hardly learn how to use my smartphone using TalkBack. I appreciate the assistance of my peers from visually impaired learners who helped me a lot to overcome these challenges"* (Participant 6).

4.1.1.2.4. Theme 4: Evaluating the Impact of Assistive Technology Use on EFL Learning

4.1.1.2.4.1. Sub-Theme 1: Improving Self-Efficacy

According to two participants, assistive technology devices and services *they used to support them to* increase their productivity in English writing skills. One of them said:

> *"I could complete a task by using a speech recognition application even if there was no one around to guide me on what to do. Hence, I can't describe my feelings. For me, my phone is my weapon. I can't imagine my situation if I abandon it. Simply, it allows me to practice writing English words much better than the traditional Braille method"* (Participant 6).

Listening skills are also one of the benefits of assistive technology applications. Accordingly, one interviewee pointed out that:

> *"In general, I use voice recording during my English lectures. These ways allow me to enhance my English listening skills because my English teacher does not repeat the explanation and pronunciation of words"* (Participant 5).

Similarly, another participant commented:

> *"When I use my smartphone, I don't face any difficulties. Simply because everything is available in the audio format"* (Participant 3).

4.1.1.2.4.2. Increasing Self-Esteem

A positive attitude toward using assistive technology is a vital factor that could increase the efficacy of the user. In the actual situation, the participants used different technology accommodations in learning English. They highlighted that the accessibility of technology builds good self-esteem. Thus, the following responses reveal this positive impact. One participant said:

"Of course, I can't avoid using my phone to learn English. Using this device helped me so much in achieving my English tasks by 50 %. Then, I became more confident in studying this subject" (Participant 3).

For a participant who was struggling to pay attention to the explanation of the English teacher, losing attention affected the level of her self-confidence. She declared that:

"During my English lectures, some students (sighted learners) make noise or talk to each other. I feel angry because I depend on my hearing sense. Consequently, I miss interesting information while my English teacher explains the lesson" (Participant 6).

The same participant expressed that using the smartphone applications like Envision (a smartphone app) compensated for her listening skills deficits. Moreover, this application empowered her to be independent by speaking out about the visual world around her.

"Unlike visually impaired students who don't use technology in the learning process, using technology accommodations today helps us so much. When I use Envision to read a printed English document, I can understand the content of the English lesson. Furthermore, this application allows me to listen carefully to the pronunciation without any noise" (Participant 1).

4.1.2. Findings from the Case Study of Robbah School for SVI

4.1.2.1. Descriptive Demographic Analysis of the Samples

Table 13: *Demographic Characteristics of Participants at Robbah School for SVI*

Variable		Total n=6	
		Range	Mean (SD)
Age	Min	15 years	16.33 (1.211)
	Max	18 years	
		Frequency	Percent (%)
Gender	Female	3	50.0
	Male	3	50.0
Visual Impairment Degree	Low Vision	2	33.3

	Blind	4	66.7
Visual Impairment Onset	Congenital	1	20.00
	Adventitious	5	80.00
Educational Level	The 3rd year of middle school	6	100.0

Table 13 shows that participants who participated in the study were two males and three females from Robbah School for SVI. This result indicates that the gender ratio for respondents in this study was equivalent, i.e., 50:50. Besides, the age of the visually impaired pupils enrolled at Robbah School for SVI ranged from 15 and 18 years old (the youngest was 15 years old, and the oldest was 18 years old). All the participants were students in a specialized educational setting (specialized school) where they learned with only their peers who had sight loss.

Also, the demographic characteristics of participants illustrate that the mean of their age was 16.33 years old, with a standard deviation of 1.211. The table 13 also shows that all the participants of this case study at Robbah School for SVI were pupils at the third middle school level. Two of them from visually impaired pupils from Robbah School for SVI who had low vision (33.3%), while four learners were blind (66.7%). Only one student had a congenital vision loss, while the rest of the five participants had acquired visual impairment. Besides, this sample consisted of SVI students in the 3rd year of middle school.

4.1.2.2. Themes Emerged

Table 14 distinctly illustrated the main themes and subthemes that emerged from the interviewees' responses to Robbah School for SVI.

Table 14: *Themes and Sub-Themes Emerged from Robbah School for SVI Sample*

Theme 1: Assistive Technology Types Used for EFL Learning
Subtheme 1: A Limited Accessibility to Assistive Technology Continuum
Theme 2: Purpose for Assistive Technology Use in EFL Learning
Subtheme 1: Braille Method for Text Input and Output

Theme 3: Challenges of using these AT tools for English learning
Subtheme 1: Lack of knowledge about Assistive Technology
Subtheme 2: Mechanical and Orthographic issues with Braille System
Subtheme 3: Stereotypical Concepts towards Visual Impairment
Theme 4: Evaluation of the Impact of Assistive Technologies in English Learning
Subtheme 2: Improving Vocabulary Learning

4.1.2.2.1. Theme 1: Assistive Technology Types Used for EFL Learning

The interview data from 5 subjects research at Robbah School for SVI exposed that all participants were using a low level of assistive technology. Most of the responses in Table 15 indicated that Braille equipment (slate and stylus) was the dominant educational tool during their English class.

Table 15: *Assistive Technology Tools Used by Respondents of Robbah School for SVI*

AT Tool	Type	Number of Respondents
Digital Voice Recorder	Duolingo	1
Talking Dictionary	Google Translate Service	1
Braille Equipment	Slate and Stylus	6

The results in Table 15 show that most participants (n=4) did not use the high and mid-tech assistive technology devices for visually impaired students. Only two (n=2) interviewees used an android application and website service in English learning. The Braille slate and stylus were essential tools for all of the respondents.

4.1.2.2.1.1. Subtheme 1*:* A Limited Accessibility to Assistive Technology Continuum

The slate and stylus Braille equipment were a backbone in English sessions as they used students with visual impairment to read and write. Answers include the following responses.

> *"We usually use the Braille slate and stylus for reading and writing in the English class"* (Participant 6).

> *"My tools are always the Braille slate and stylus. Of course, I use them mainly to read a text or my answer. I also use them to write down my lesson"* (Participant 5).
>
> *"In my opinion, the Braille slate and stylus are important for me to read and write"* (Participant 2).

The interview data finding revealed the applications EFL students used in applying assistive technology strategies for EFL learning were Google Translate service (n=1) and Duolingo (n=1). Both participants expressed that the Braille materials are not the only educational tools for them to learn English. One of them commented that she had limited access to use Google translation service to enrich her English vocabulary by using her mother's phone.

> *"I use a smartphone to search for specific English rules. I am also interested in learning new vocabulary. So, I look for related videos on YouTube channels. Then, I listen to the explanation of some teachers. Unfortunately, I don't have the right to access this website because I don't have a mobile phone. Therefore, I sometimes use my mother's phone"* (Participant 3).

Another pupil with a visual impairment from this special school pointed out that using a talking dictionary assisted her in enriching her lexis. Hence, she said:

> *"My phone has a significant application. I use a talking dictionary called* Duolingo. *It helped me learn how to pronounce some new English words appropriately"* (Participant 4).

However, two interviewees reported that they used some smartphone apps. They had not the right to use it during English lessons.

4.1.2.2.2. Theme 2: Purpose for Assistive Technology Use in EFL Learning

The Braille method was the most low-tech assistive technology used among EFL visual-impaired students. They used these mechanical devices (slate and stylus) for only text input (writing) and text input (reading). These educational materials were outdated (old-fashioned) tools where the physical action of users activates the direct embossing of Braille dots. However, participants considered using the Braille system the only way to practice English.

4.1.2.2.2.1. Subtheme 1: Accessibility to Printed Information

This subtheme showed that the only purpose behind using Braille tools in English learning for EFL students who were visually impaired was to read and write. Accordingly, most visually impaired pupils expressed that these resources are necessary for documenting what they have learned. Some responses were:

> *"Our only tool to read and write during English class. We read tasks or a text from the English book. Then, we write our answer"*(Participant 1).
>
> *"Braille system is a way for reading and writing. For example, my English teacher asked us to read a text from my English book. She also commands us to write specific sentences or words. Because we are novice English learners, she dictates what she said letter by letter"*(Participant 3).
>
> *"During English lessons, we read and write using Braille*" (Participant 6).

4.1.2.2.3. Theme 3: Challenges of Using Assistive Technology Tools for EFL Learning

4.1.2.2.3.1. Subtheme 1: Lack of knowledge about Assistive Technology

Lack of awareness and knowledge about assistive technology was a prominent barrier to using it in general and applying it to English learning among the respondents. One of the visually impaired students said:

"I don't use any tools for learning English outside of my classroom. However, I believed that one day some invention would be available for visually impaired pupils to develop their educational level"(Participant 2).

Limited availability was another factor that impacted the shortage in knowledge about assistive technology. Thus, an interviewee stated:

"My classmate said she uses her smartphone to learn new English words. However, I am not very interested in learning the English language; I guess using this smartphone is a dream for me"(Participant 6).

4.1.2.2.3.2. Subtheme 2: Mechanical and Orthographic issues with Braille System

Although there is a wide range of AT devices, most visually impaired students used Braille slate and stylus as their literacy medium. These resources represent the level of the low-tech assistive technology continuum. For instance, in reading English, lack of experience with characteristics of Braille orthography of 'j' and 'g' letters yielded in slow reading speed of one of the learners with visual impairments.

"I feel confused when I read English words. For example, I struggle to distinguish between the letters 'g' and 'j' because they have similar pronunciations. My classmate sometimes helps me differentiate between them when our teacher dictates a word. She often tells me it is 'g' like in the French word 'garçon.' Then, I recognize the correct letter" (Participant 5).

Based on the comments of two participants, exposure to a long Braille text affected their tactual acuity. The first respondent said:

"I don't face any problem in reading or writing English. However, I am a faster reader and writer. I must be conscious of the movement between lines and retrieving previously read information" (Participant 1).

The second participant declared that the extensive effort of two-handed Braille reading techniques utilizing the index and middle fingers affected their reading speed.

"Braille reading involves using my index and middle fingers to recognize all the characters on a line. I was struggling with reading. When I read long text, I need to be very careful not to skip some words in the text. But you know what? I lost my vision to a great degree in the primary school stage. Thus, I didn't accept the Braille system until a few years ago" (Participant 2).

4.1.2.2.3.3. Subtheme 3: Stereotypical Concepts towards Visual Impairment

Stereotypical Concepts towards Visual Impairment was a critical issue that influenced visually impaired students' ability to acquire or use AT as an educational tool. The parents' misconceptions of one of the participants were the main reason that impacted accessibility to AT tools and applications.

"To have a smartphone is a dream for me. I am interested in using this device to learn English, but my parent promised me if I become a high school student. Then, they will purchase a new mobile phone for me. However, my mother is unsure if I can use it appropriately because I cannot see as sighted people" (participant 3).

4.1.2.2.4. Theme 4: Evaluation of the Impact of Assistive Technologies in English Learning

4.1.2.2.4.1. Sub-Them 1: Improving Vocabulary Learning

Two participants notably captured an interesting position toward using the smartphone for English learning. Google Translate service was an example of assistive technology

applications for one of the participants. She emphasized a positive attitude toward using her smartphone to explore new English terms.

> *"I really liked how Google Translation has allowed me to develop my ability to acquire a new set of English vocabularies. Without using that way, and I think it would necessitate a very long period"* (Participant 4).

One of the respondents indicated that she enjoyed using the electronic version of the English dictionary so much that it provided her with an immediate audio response. She preferred this method over a Braille dictionary because there was a shortage of volume. Then, she may be unable to find the target word's meaning.

> *"I absolutely loved the idea of a different technique to quickly get information about English words without wasting time checking a huge number of printed Braille pages at our school library. Even those books are not usually available because they bring it from the library of Robbah municipality"* (Participant 3).

4.2. Presentation and Analysis of Quantitative Findings

4.2.1. Test of Normality Distribution

a) Graphical method

Plotting a histogram of the variables of interest provided an illustration of the shape of the distribution.

The histogram of figure 12 clarifies that the histogram's data on the left (pre-test) is approximately distributed as the mean reading speed roughly in the middle of the curve peak, i.e., the mean was between the range of 55 to 60 wpm. The second data histogram on the right (post-test) shows that data was close to the normal distribution as the mean reading rate was 60 to 65 wpm, that is, in the area of the peak of the bell curve.

Figure 12: *A Graphical Representation of Normal Distribution of the Pre- and Post-Tests Data of the EL-Oued University Sample*

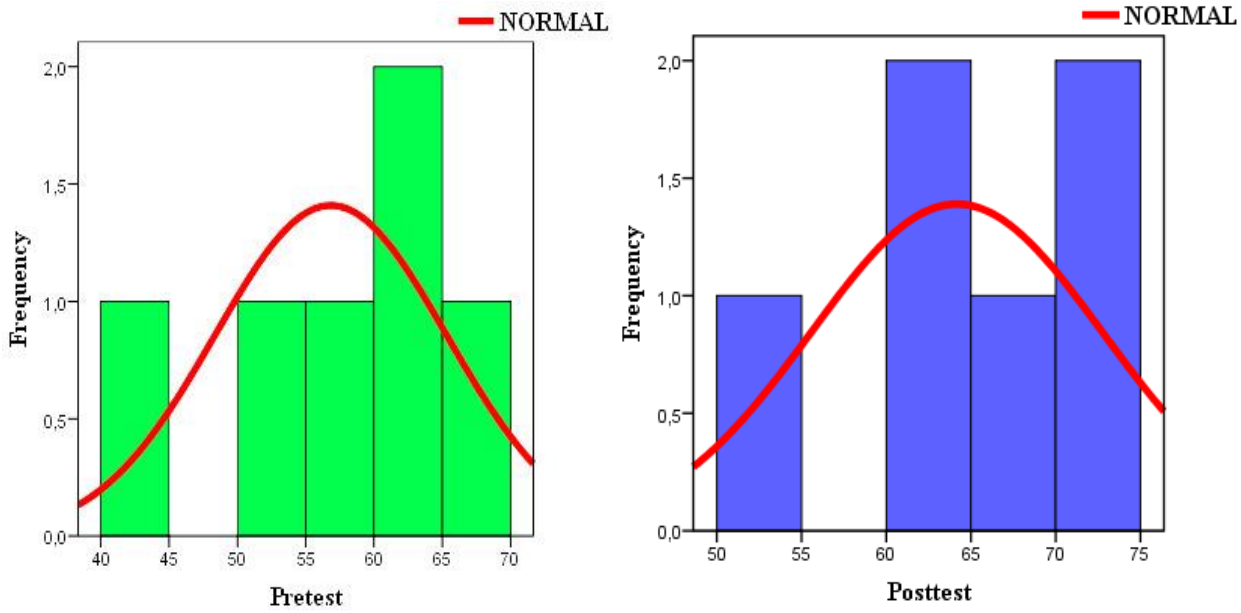


Figure 13*: A Graphical Representation of Normal Distribution of the Pre- and Post-Tests Data of the Robbah School for SVI Sample*

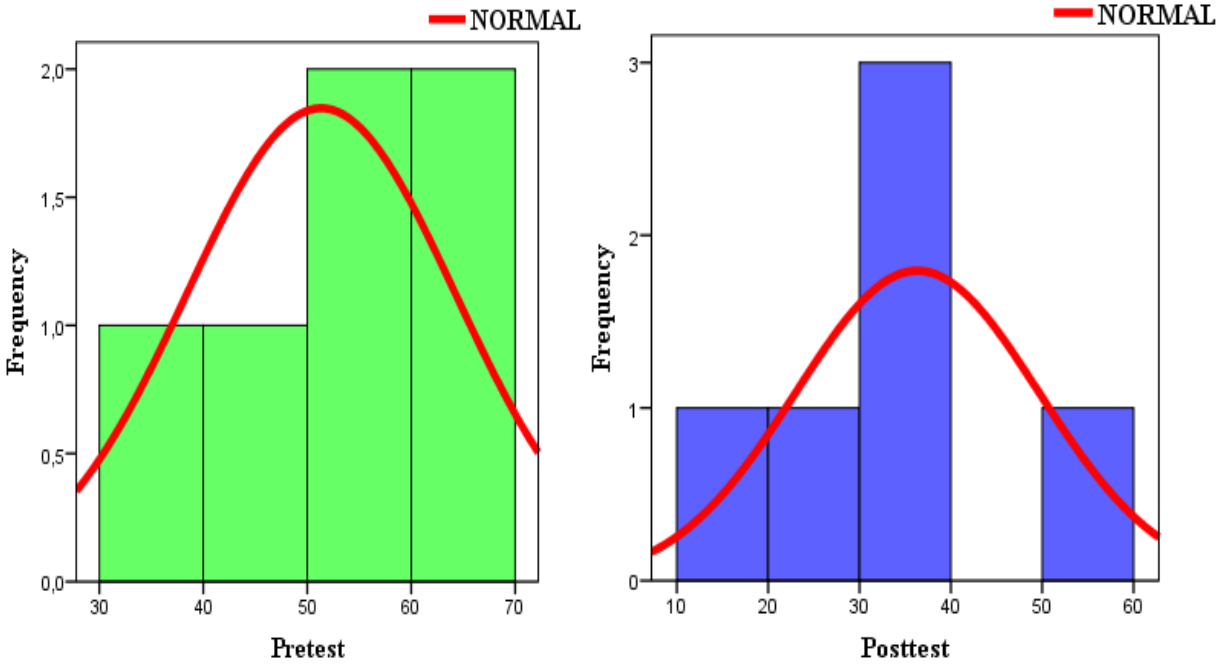


Figure 13 illustrates that in the data on the left histogram (pre-test), the mean reading speed approximately crosses the peak of the curve. The second data histogram on the right (post-test) shows that the mean reading rate was 30 to 40 wpm, that is, in the area of the peak of the bell curve. Therefore, the data set was near to the normal distribution.

a) Statistical Analysis of Normality Distribution Test

Since the sample size is small (n=6 for each sample), the assumption that the samples follow the normal distribution was checked based on the Shapiro-Wilk test at a significance level of 0.05 (α=0.05).

The result of this test is expressed as '*accept Normality*' or '*reject Normality*,' with P-value.

- **If $p \leq 0.05$ and $W = 1$:** The null hypothesis is rejected (i.e., the variable is NOT normally distributed).
- **If $p > 0.05$ and $W < 1$:** The null hypothesis is not rejected (i.e., the variable is NORMALLY distributed).

Note. 'W' refers to a value of the Shapiro-Wilk test

The Shapiro-Wilk test showed that the variables were significantly normally distributed. More accurately, the decision is to retain the assumption of normality based on these statistics.

a. Findings of EL-Oued University Sample

Table 16: *Shapiro-Wilk Test Results of the EL-Oued University Sample*

Group		Shapiro-Wilk Test			
	Data	N	Statistic	df	Sig.
VIS at EL-Oued University	Pretest	6	0.929	6	0.574
	Post-test	6	0.960	6	0.823

Note. VIS refers to visually impaired students

Table 16 illustrates that, according to Shapiro-Wilk tests, the distributions were:

Braille Paper Test: $\{W(6) = 0.929, p = 0.574 > a = 0.05\}$

An electronic Braille display Test: $\{W(6) = 0.960, p = 0.823 > a = 0.05\}$

Therefore, the results of the Shapiro-Wilk test provided evidence that the data were normally distributed

b. Findings of Robbah School for SVI Sample

Table 17: *Shapiro-Wilk Test Results of Robbah School for the SVI Sample*

Group			Shapiro-Wilk Test		
	Data	N	Statistic	df	Sig.
VIS at Robbah School for SVI	Pretest	6	0.948	6	0.727
	Post-test	6	0.950	6	0.743

Note. VIS refers to visually impaired students

Table 17 illustrates that, according to Shapiro-Wilk tests, the distributions were:

Braille Paper Test: $\{W(6) = 0.948, p = 0.727 > a = 0.05\}$

An electronic Braille display Test: $\{W(6) = 0.950, p = 0.743 > a = 0.05\}$

4.2.2. Statistical Description of Hypotheses Testing

4.2.2.1. The Results of The Paired t-test for Statistical Difference

4.2.2.1.1. The 1st Null Hypothesis Testing

The scores of reading speed (WPM) of visually impaired learners at EL-Oued University were provided in Table 18.

Table 18: *Reading Speed Scores of Visually Impaired Students at EL-Oued University*

	Reading Speed (WPM)	Reading Speed (WPM)
Participants	Braille Paper	Braille Display
1	42	50
2	56	63
3	60	67
4	66	74
5	63	71
6	54	60

Note. WPM refers to words per minute

- **Calculation Mean and Standard Deviation**

The mean sample formula is given as the average of all the observations. It is expressed as: Mean = {Sum of Observation} ÷ {Total numbers of Observations}.

$$\bar{x} = \frac{\sum x_i}{n}$$

$$\bar{x}1 = \frac{42 + 56 + 60 + 66 + 63 + 54}{6} = 56.83$$

$$\bar{x}2 = \frac{50 + 63 + 67 + 74 + 71 + 60}{6} = 64.17$$

$$S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n - 1}}$$

$S =$ Standard Deviation

$n =$ Total number of observations

$x_i =$ The observed values of a sample item

$\bar{x} =$ The mean value of the observations

$$S1 = \sqrt{\frac{(42 - 56.83)^2 + (56 - 56.83)^2 + (60 - 56.83)^2 + (66 - 56.83)^2 + (63 - 56.83)^2 + (54 - 56.83)^2}{6 - 1}}$$

$$S1 = 8.495$$

$$S2 = \sqrt{\frac{(50 - 64.17)^2 + (63 - 64.17)^2 + (67 - 64.17)^2 + (74 - 64.17)^2 + (71 - 64.17)^2 + (60 - 64.17)^2}{6 - 1}}$$

$$S2 = 8.612$$

Median when n is even (no single middle value) equals the sum of the mean of the two central values divided by 2. In the formula of median below, *n* refers to the number of terms and '*th'* to the order of n number.

$$median = \left\{\frac{\left(\frac{n}{2}\right)th + \left(\frac{n}{2}+1\right)th}{2}\right\}$$

For the 1st set of data, the order of terms was:

42, 54, 56, 60, 63, 66

Thus, the median is:

$$median\ 1 = \left\{\frac{\left(\frac{6}{2}\right)th + \left(\frac{6}{2}+1\right)th}{2}\right\} = \left\{\frac{3th + 4th}{2}\right\} = \frac{56+60}{2} = 58.00$$

For the 2nd set of data, the order of terms was:

50, 60, 63, 67, 71, 74

Thus, the median is:

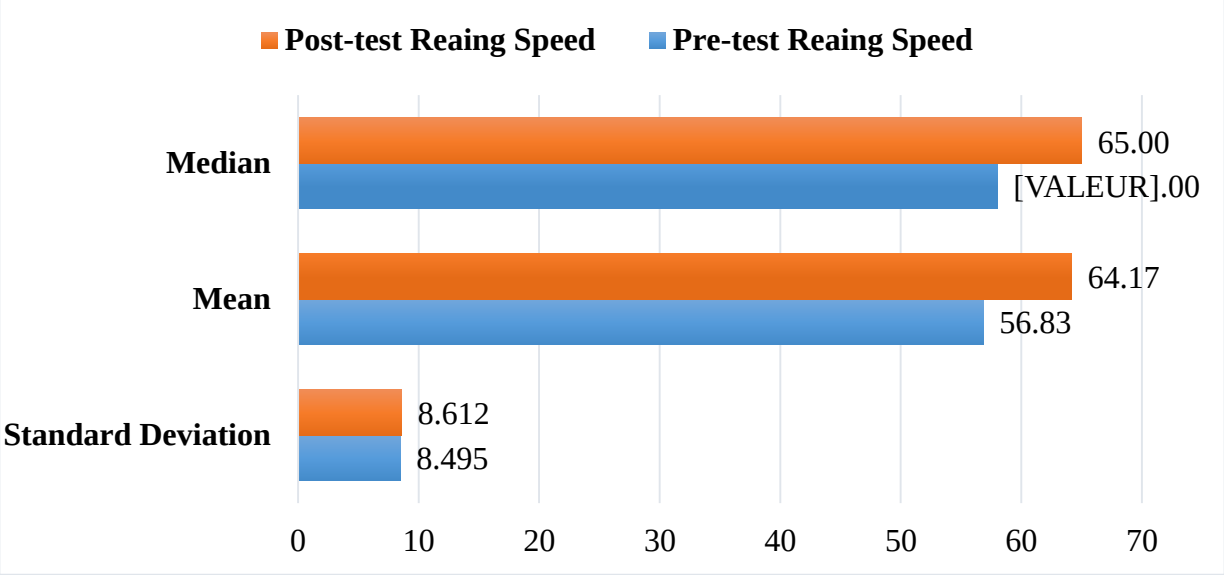
$$median\ 2 = \left\{\frac{\left(\frac{6}{2}\right)th + \left(\frac{6}{2}+1\right)th}{2}\right\} = \left\{\frac{3th + 4th}{2}\right\} = \frac{63+67}{2} = 65.00$$

Table 19: *The pre-test and post-test measurements of EL-Oued University Sample*

	Reading Speed (WPM) Braille Paper	Reading Speed (WPM) Braille Display
Median	58.00	65.00
Mean	56.83	64.17
Standard Deviation	8.495	8.612

Table 19 illustrates that for the pre-test phase, the median was 58 wpm, the mean was 65.83 wpm, and the standard deviation was 8.495. For the post-test stage, the median was 65 wpm, the mean was 64.17 wpm, and the standard deviation was 8.612. Based on these statistics above, the paired t-test is used to test whether the mean difference between pairs (two groups of the same sample) of measurements is zero or not. Figure 14 represents these findings graphically.

Figure 14: *A Histogram Illustration of the Median, Mean, and Standard Deviation of Pre- and Post-Tests of the EL-Oued University Sample*



Based on these statistics above, the paired *t*-test is used as a method to test whether the mean difference between pairs (two groups of the same sample) of measurements is equal or not.

Step 1: Statement of the Hypothesis

H_{01}: There is no significant difference between the reading speed of English using Braille paper or an electronic Braille display among visually impaired students at EL-Oued University.

In other words, the difference between the means of pretest and post-test reading speed task equals 0.

$$H_{01}: \mu 1=\mu 2$$

To examine evidence to test the null hypothesis or not. The researcher conducted the following steps of paired t-test to compare the means of two pairs.

Step 2: Calculation of the Difference

Table 20: *Differences between Pre- and Post-Tests of VIS at EL-Oued University*

Participants	Reading Speed (WPM) Braille Paper	Reading Speed (WPM) Braille Display	Difference
1	42	50	8
2	56	63	7
3	60	67	7
4	66	74	8
5	63	71	8
6	54	60	6

Table 20 shows positive score differences between reading speed using Braille paper and an electronic Braille display. The difference was the subtraction of each post-test score from each pre-test score.

Step 3: Calculation of the Mean Difference and the Standard Deviation of the Difference

a) Calculating the mean difference according to the equation:

$$\bar{d} = \frac{\Sigma_D}{n}$$

Where the 'D' refers to the difference between a pair of scores and 'Σ_D' is the sum of the difference scores. In this case, the average difference gives:

$$\bar{d} = \frac{d1 + d2 + \cdots + d_n}{n}$$

$$\bar{d} = \frac{(-8) + (-7) + (-7) + (-8) + (-8) + (-6)}{6} = -7.3333$$

b) Calculating the standard deviation of difference:

From the estimated mean difference, the standard deviation of difference is:

$$s_D = \sqrt{\frac{\sum\left(d_1 - \bar{d}\right)^2 + \left(d_2 - \bar{d}\right)^2 + \cdots + \left(d_n - \bar{d}\right)^2}{n-1}}$$

$$= \sqrt{\frac{(8 - 7.3333)^2 + (7 - 7.3333)^2 + (7 - 7.3333)^2 + (8 - 7.3333)^2 + (8 - 7.3333)^2 + (6 - 7.3333)^2}{6-1}}$$

$$s_D = \sqrt{\frac{3.334}{5}} = 0.8165$$

Step 4: Calculation of *t*-Value (Test Statistic) and Degrees of Freedom

a) The value of the calculated t-statistic using the formula below is referred to as:

$$t = \frac{\bar{d} - 0}{s_D/\sqrt{n}}$$

$$t = \frac{-7.3333}{0.8165/2.4494} = \frac{-7.3333}{0.3333} = -22.0021$$

b) The number of degrees of freedom was calculated as follows:

$$df = n - 1$$

$$df = 6 - 1 = 5$$

Step 5: Calculation of Critical *t*-Value

A critical-T value is a "cut-off point" on the t distribution. Table 21 provides the results of this value.

Table 21*: T-Critical Value for a Two-Tailed Test with α = 0.05 and 5 Degrees of Freedom*

cum. prob	t .50	t .75	t .80	t .85	t .90	t .95	t .975	t .99	t .995	t .999	t .9995
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587

According to Table 21, the critical t-value (for two-tails) associated with degrees of freedom 5 (n-1=6-1) is ± 2.571 for the two-tailed test.

Step 6: Decision

Table 22: *Summary of Paired T-Test for EL-Oued University Sample*

Mean difference ($\bar{d}$)	$\mathbf{-7.3333}$
Standard Deviation of difference (S_D)	0.8165
Sample Size	6
Degrees of freedom	5
Calculated t value	-22.0021
Critical t value	± 2.571 (two-tailed test)
Significance Level (α)	0.05
P-value	< 0.05

Table 22 above demonstrates that the calculated t-value equals-22.0021 which exceeds the cutoff of the critical t-value of ±2.571 for the two-tailed at the 0.05 level of significance and 5 degrees of freedom. In other terms, the test statistic $t_{\text{calculated}}$ is not in the 95% region of acceptance: $[-2.5706; +2.5706]$. Therefore, the p-value associated with the t-ratio (calculated t-value) is less than the 95% confidence interval, i.e., $p < \alpha = 0.05$.

The researcher used Statistical Package for Social Sciences (SPSS) software to calculate the p-value. It was p=0.000003603. Hence, the chance of type I error (rejecting a correct H_0) is small: 0.000003603 (0.00036%). Since the p-value is less than α and the value of $t_{\text{calculated}}$ is lower than the value of t_{critical}, the decision then was to reject the second null hypothesis.

4.2.2.1.2. The 2nd Null Hypothesis Testing

The scores of reading speed (WPM) of visually impaired learners at Robbah School for SVI were provided in Table 23.

Table 23: *Reading Speed Scores of Visually Impaired Students at Robbah School for SVI*

Participants	Reading Speed (WPM) Braille Paper	Reading Speed (WPM) Braille Display
1	32	18
2	41	28
3	66	58
4	52	39
5	63	36
6	54	39

Note. WPM refers to words per minute

- **Calculation Median, Mean and Standard Deviation**

$$\bar{x} = \frac{\sum x_i}{n}$$

$$\bar{x}1 = \frac{32 + 41 + 66 + 52 + 63 + 54}{6} = 51.33$$

$$\bar{x}2 = \frac{18 + 28 + 58 + 39 + 36 + 39}{6} = 36.33$$

$$S = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n - 1}}$$

$$S1 = \sqrt{\frac{(32 - 51.33)^2 + (41 - 51.33)^2 + (66 - 51.33)^2 + (52 - 51.33)^2 + (63 - 51.33)^2 + (54 - 51.33)^2}{6 - 1}}$$

$$= \sqrt{\frac{(-19.33)^2 + (-10.33)^2 + (14.67)^2 + (0.67)^2 + (11.67)^2 + (2.67)^2}{5}}$$

$$= \sqrt{\frac{373.64 + 106.70 + 215.20 + 0.44 + 136.18 + 7.12}{5}}$$

$$S1 = 12.956$$

$$S2 = \sqrt{\frac{(18 - 36.33)^2 + (28 - 36.33)^2 + (58 - 36.33)^2 + (39 - 36.33)^2 + (36 - 36.33)^2 + (39 - 36.33)^2}{6 - 1}}$$

$$= \sqrt{\frac{(18.33)^2 + (-8.33)^2 + (21.67)^2 + (2.67^2 + (0.33)^2 + (2.67)^2}{5}}$$

$$= \sqrt{\frac{335.98 + 69.38 + 469.58 + 7.12 + 0.10 + 7.12}{5}}$$

$$S2 = 13.337$$

$$median = \left\{\frac{\left(\frac{n}{2}\right)th + \left(\frac{n}{2} + 1\right)th}{2}\right\}$$

For the 1st set of data, the order of terms was:

32, 41, 52, 54, 63, 66.

Thus, the median is:

$$median\ 1 = \left\{\frac{\left(\frac{6}{2}\right)th + \left(\frac{6}{2} + 1\right)th}{2}\right\} = \left\{\frac{3th + 4th}{2}\right\} = \frac{52 + 54}{2} = 53.00$$

For the 2nd set of data, the order of terms was:

18, 28, 36, 39, 39, 58

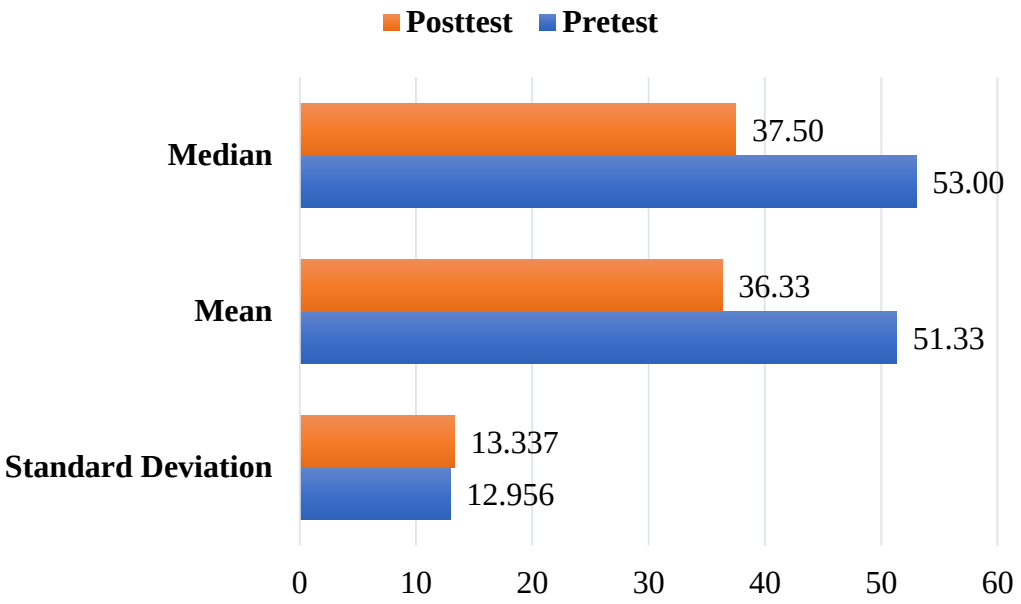
$$median\ 2 = \left\{\frac{\left(\frac{6}{2}\right)th + \left(\frac{6}{2} + 1\right)th}{2}\right\} = \left\{\frac{3th + 4th}{2}\right\} = \frac{36 + 39}{2} = 37.50$$

Table 24: *The Pre- and Post-Tests Measurments of the Robbah School for SVI Sample*

	Reading Speed (WPM)	Reading Speed (WPM)
	Braille Paper	Braille Display
Median	53.00	37.50
Mean	51.33	36.33
Standard Deviation	12.956	13.337

Table 24 illustrates that for the pre-test phase, the median was 53 wpm, the mean was 51.33 wpm, and the standard deviation was 12.956. For the post-test stage, the median was 37.50 wpm, the mean was 36.33 wpm, and the standard deviation was 13.337. Based on these statistics above, the paired t-test is used to test whether the mean difference between pairs (two groups of the same sample) of measurements is zero or not. Figure 14 represents these findings graphically.

Figure 15: *A Histogram Illustration of the Median, Mean, and Standard Deviation of Reading Speeds of the Robbah School for SVI Sample*



Based on these statistics above, the paired *t*-test is used as a method to test whether the mean difference between pairs (two groups of the same sample) of measurements is equal or not.

Step 1: Statement of the Hypothesis

H_{02}: There is no significant difference between the reading speed of English using Braille paper or an electronic Braille display among visually impaired students at Robbah School for SVI.

In other words, the difference between the means of observation before and after using an electronic Braille display for a reading task equals 0.

$$H_{02}: \mu 1=\mu 2$$

To examine evidence to test the null hypothesis or not. The researcher conducted the following steps of paired t-test to compare the means of two pairs.

Step 2: Calculation of the Difference

Table 25: *Differences between Pre-test and Post-test of VIS at Robbah School for SVI*

Participants	Reading Speed (WPM) Braille Paper	Reading Speed (WPM) Braille Display	Difference
1	32	18	-14
2	41	28	-13
3	66	58	-8
4	52	39	-13
5	63	36	-27
6	54	39	-15

Table 25 demonstrates that the score differences between reading speed using Braille paper and an electronic Braille display were negative.

Step 3: Calculation of the Mean Difference and the Standard Deviation of the Difference

a) Calculating the mean difference:

$$\bar{d} = \frac{d1 + d2 + \ldots + d_n}{n}$$

$$= \frac{(-14) + (-13) + (-8) + (-13) + (-27) + (-15)}{6} = -15$$

b) Calculating the standard deviation of the mean:

$$s_D = \sqrt{\frac{\left(d_1 - \bar{d}\right)^2 + \left(d_2 - \bar{d}\right)^2 + \cdots + \left(d_n - \bar{d}\right)^2}{n - 1}}$$

$$= \sqrt{\frac{(14-15)^2 + (13-15)^2 + (8-15)^2 + (13-15)^2 + (27-15)^2 + (15-15)^2}{6-1}}$$

$$s_D = \sqrt{\frac{202}{5}} = 6.356$$

Step 4: Calculation of *t*-Value (Test Statistic) and Degrees of Freedom

a) The value of the calculated t-statistic was:

$$t = \frac{\bar{d} - 0}{s_D / \sqrt{n}}$$

$$t = \frac{-15 - 0}{6.356/2.449} = \frac{-15}{2.595} = -5.78$$

b) The number of the degrees of freedom:

$$df = n - 1$$

$$df = 6 - 1 = 5$$

Step 5: Calculation of Critical *t*-Value

A critical-T value is a "cut-off point" on the t distribution. Table 26 provides the results of this value.

Table 26: *T-Critical Value for a Two-Tailed Test with α = 0.05 and 5 Degrees of Freedom*

cum. prob	***t* .50**	***t* .75**	***t* .80**	***t* .85**	***t* .90**	***t* .95**	***t* .975**	***t* .99**	***t* .995**	***t* .999**	***t* .9995**
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	**2.571**	3.365	4.032	**5.893**	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959

Then, the critical t-value for this two-tailed test is $t_{caritical}$=±2.571 for α=0.05 and degrees of freedom=5.

Step 6: Decision

Table 27: *Summary of Paired T-Test for Robbah School for SVI Sample*

Mean difference ($\bar{d}$)	$\mathbf{-15}$
Standard Deviation of difference (S_D)	6.356
Sample Size	6
Degrees of freedom	5
Calculated t value	−5.7806
Critical t value	± 2.571 (two-tailed test)
Significance Level (α)	0.05
P-value	< 0.05

Table 27 above demonstrates that the calculated t-value equals -5.7806, that is, it exceeds the cutoff of the critical t-value of ±2.571 for the two-tailed test at the 0.05 level of significance and 5 degrees of freedom. In other words, the test statistic $t_{calculated}$ does not lie in the 95% acceptance region: $[-2.5706; +2.5706]$.

Therefore, the p-value associated with the t-ratio (calculated t-value) is less than the 95% confidence interval, i.e., $p < \alpha = 0.05$. The researcher used SPSS to calculate the p-value. It was p=0.00218. It means that the chance of type I error (rejecting a correct H_0) is small: 0.00218 (0.22%). Since the p-value is less than α and the value of $t_{\text{calculated}}$ is lower than the value of t_{critical}, the decision then was to reject the second null hypothesis.

4.2.2.1.3. The 3rd Null Hypothesis Testing

The following information has been provided in Table 28 from the previously obtained data:

Table 28: *Samples Size, Mean, Standard Deviation*

Sample Mean 1 ($\bar{X}_1$)	36.33
Sample Standard Deviation 1 (S_1)	13.337
Sample Size (n_1)	6
Sample Mean 2 ($\bar{X}_2$)	64.17
Sample Standard Deviation 2 (S_2)	8.612
Sample Size (n_2)	6
Significance Level (α)	0.05

1. Statement of the Hypothesis

The following null hypotheses needed to be tested:

H_{03}: No difference exists between visually impaired pupils at Robbah School for SVI and visually impaired learners at EL-Oued University regarding the reading speed of English using an electronic Braille display.

$$H_{03}: \mu 1 = \mu 2$$

This hypothesis corresponds to a two-tailed test, for which a t-test for two population means, two independent samples, and unknown population standard deviations will be used. An independent samples t-test was performed comparing the mean consistency scores of reading rate using an electronic Braille display between visually impaired pupils at Robbah School for SVI and EL-Oued University.

2. Calculating Degrees of Freedom and t-Value

The degrees of freedom are computed as follows, assuming that the population variances are equal:

$$dfTotal = df1 + df2 = 5 + 5 = 10\ df$$

The table 29 provides the critical t-value results corresponding to 10 degrees of freedom. Since it is assumed that the population variances are equal, the t-statistic is computed as:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

$$t = \frac{36.33 - 64.17}{\sqrt{\frac{(8.612)^2}{6} + \frac{(13.337)^2}{6}}} = -4.295$$

3. Calculation of Critical *t*-Value

Table 29: *T-Critical Value for a Two-Tailed Test with α = 0.05 and 10 Degrees of Freedom*

cum. prob	t .50	t .75	t .80	t .85	t .90	t .95	t .975	t .99	t .995	t .999	t .9995
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587

4. Decision

Table 30: *Summary of Independent T-Test Statistics*

Sample Mean 1 ($\bar{X}_1$)	36.33
Sample Standard Deviation 1 (S_1)	13.337
Sample Size (n_1)	6
Sample Mean 2 ($\bar{X}_2$)	64.17
Sample Standard Deviation 2 (S_2)	8.612
Sample Size (n_2)	6
Degrees of freedom	10
Calculated t value	-4.295
Critical t value	±2.228 (two-tailed test)
Significance Level (α)	0.05
P-value	< 0.05

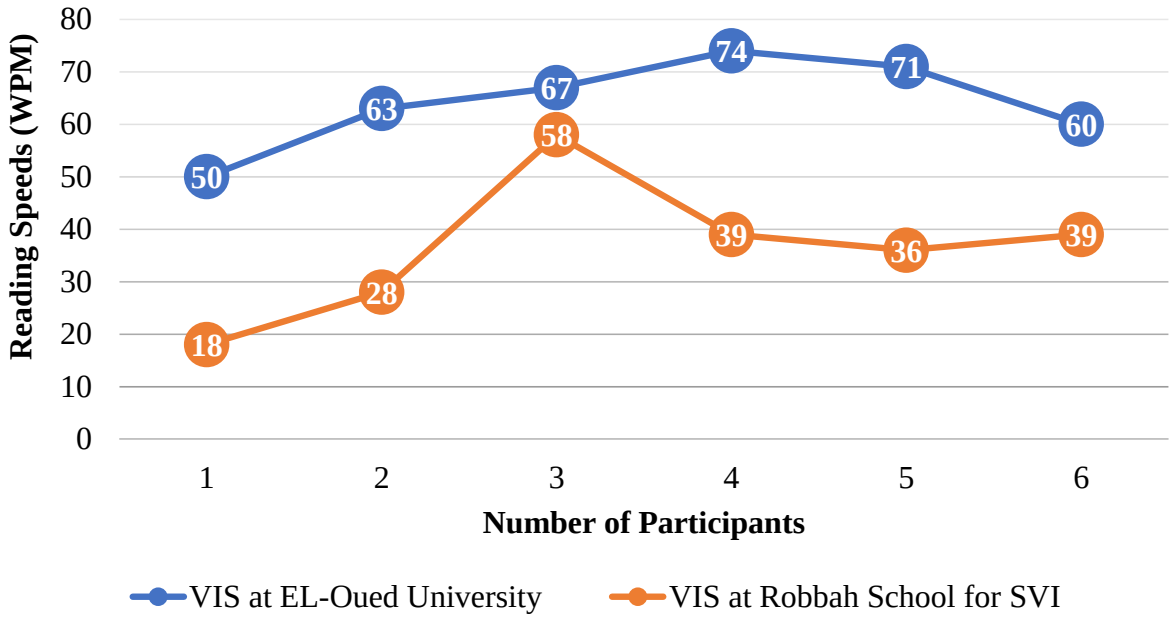
Table 30 above illustrates that the calculated t-value equals -4.295. This value exceeds the cut-off of the critical t-value of ±2.228 for the two-tailed at the 0.05 level of significance and 10 degrees of freedom. These results mean that the test statistic t calculated is not in the 95% acceptance region: $[-2.228;\ +2.228]$.

Therefore, the p-value associated with the t-ratio (calculated t-value) is less than the significance level of 0.05, i.e., $p < \alpha = 0.05$. The researcher used SPSS to calculate the p-value. It was p=0.0016, and since p< α (0.0016< 0.05), It means that the chance of type I error (rejecting a correct H_0) is small: 0.0016 (0.16%). In other words, the independent samples t-test revealed that the third null hypothesis is rejected.

4.2.2.1.3.1. Analyzing Between Groups Differences

a) Comparison of Reading Speeds between Samples

Figure 16: *Reading speeds using an electronic Braille display between Samples*



From Figure 16, the highest reading speed rate was 74 words per minute for the visually impaired sample of EL-Oued University, while it was 58 words per minute for VIS pupils at Robbah School for SVI. These results were based on the measurements of the reading speed test using an electronic Braille display. This figure also demonstrates that the second sample's lowest reading speed score of English using the same device was 18 words per minute. For the sample of SVI at EL-Oued University, 50 words per minute were the lowest reading speed score.

c. Comparison of Participants' Age

Figure 17 illustrates that 50% of SVI interviewees were 25 years old. For the group of SVI at EL-Oued University, the youngest was 21 years old (16%), one participant (17%) was 23 years old, and the oldest respondent was 26 years old (17%).

Furthermore, Figure 17 shows that the age group of VI pupils at Robbah School ranged from 15 to 18 years old. For the group of SVI at EL-Oued University, the youngest was 21 years old, and the oldest was 26 years old.

Figure 17: *Comparison of the Participants' Ages between VIS at Robbah School for SVI and EL-Oued University Samples*

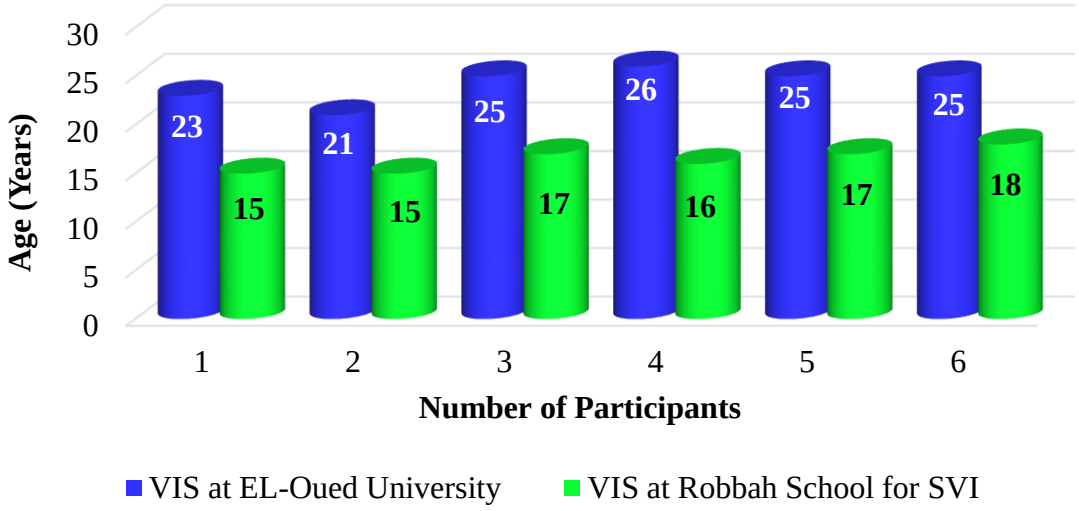


Figure 18: *Mean reading speed by Age using an electronic Braille display of the Robbah School for SVI Sample*

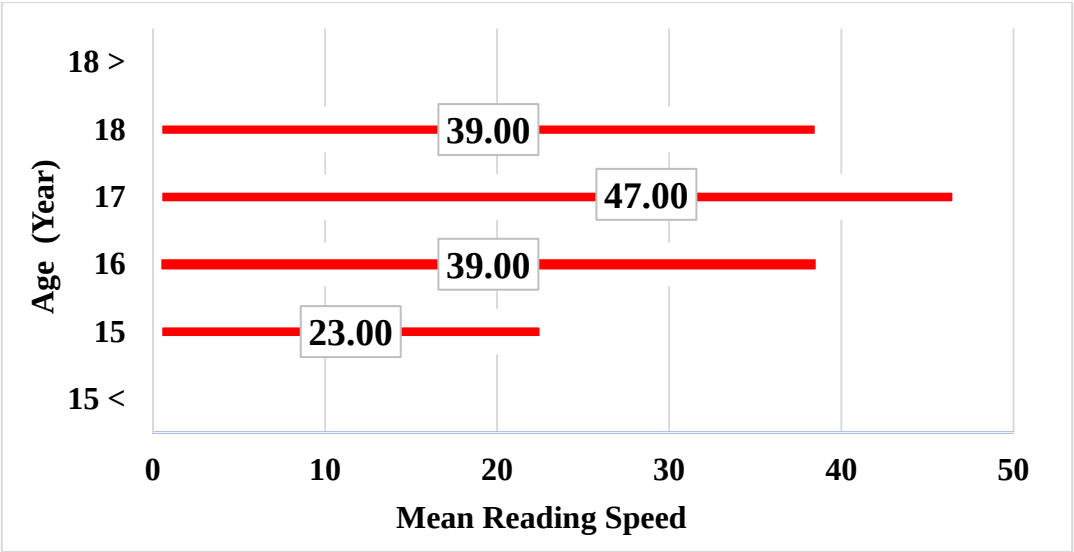


Figure 18 shows that the mean reading speed of English using a an electronic Braille display was 23.00 wpm for 15 years old. Besides, the average 16 years old (39.00 wpm) was

equivalent to 18 years old (39.00 wpm). Mean 17 years old scored the highest average among the participants. Consequently, the total mean reading speed by age was calculated as follows:

$$\text{Total of Mean Reading Speed} = \frac{\text{The sum of mean Reading Speed}}{\text{The total Number of Observations}}$$

$$= \frac{23 + 23 + 39 + 47 + 47 + 39}{6} = 36.33$$

Figure 19: *Mean Reading Speed by Age Using an electronic Braille Display of the EL-Oued University Sample*

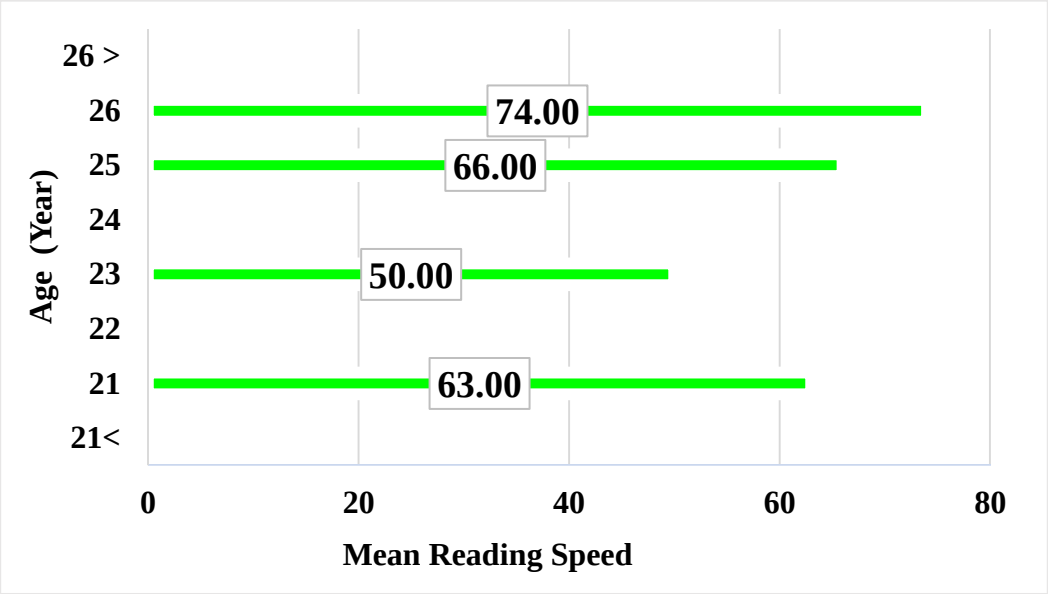


Figure shows that the mean reading speed of English using an electronic Braille display was 63.00 wpm for 21 years old. In addition, the average 23 years old was 50.00 wpm, the mean 25 years old was 66.00 wpm, and the highest average reading speed was for 26 years old. Accordingly, the total mean reading speed by age was calculated as:

$$\text{Total of Mean Reading Speed} = \frac{\text{The sum of mean Reading Speed}}{\text{The total Number of Observations}}$$

$$= \frac{63 + 50 + 66 + 66 + 66 + 74}{6} = 64.17$$

d. Comparison of Reading Speed Test Based on Gender and Sight Loss Degree

Table 31 describes the reading speeds of students with visual impairment in the 3rd year of middle school at Robbah School for SVI.

Table 31: *Reading Speeds of VIS at Robbah School Based on Gender and VI Degree*

Participants	Gender	Visual Impairment Degree	Reading Speed (WPM)
1	Female	Low Vision	18
2	Female	Low Vision	28
3	Female	Blind	58
4	Male	Blind	39
5	Male	Blind	36
6	Male	Blind	39

Table 31 describes the reading speeds of students with visual impairment at Robbah School for SVI. Using an electronic Braille display, the minimum score was 18 words per minute for a female with low vision while 39 words per minute for a blind male. Then, the difference was 21 words per minute.

Table 32: *Reading Speeds of VIS at EL-Oued University Based on Gender and VI Degree*

Participants	Gender	Visual Impairment Degree	Reading Speed (WPM)
1	Female	Low Vision	50
2	Female	Low Vision	63
3	Female	Blind	67
4	Female	Blind	74
5	Male	Blind	71
6	Male	Blind	60

Table 32 describes the reading speeds of pupils with visual impairment at Robbah School for SVI. Using an electronic Braille display, the minimum score was 50 words per minute for a female with low vision while 74 words per minute for a blind male. Then, the difference was 24 words per minute.

Figure 20: *The Average Reading Speed by Gender and Degree of Visual Impairment*

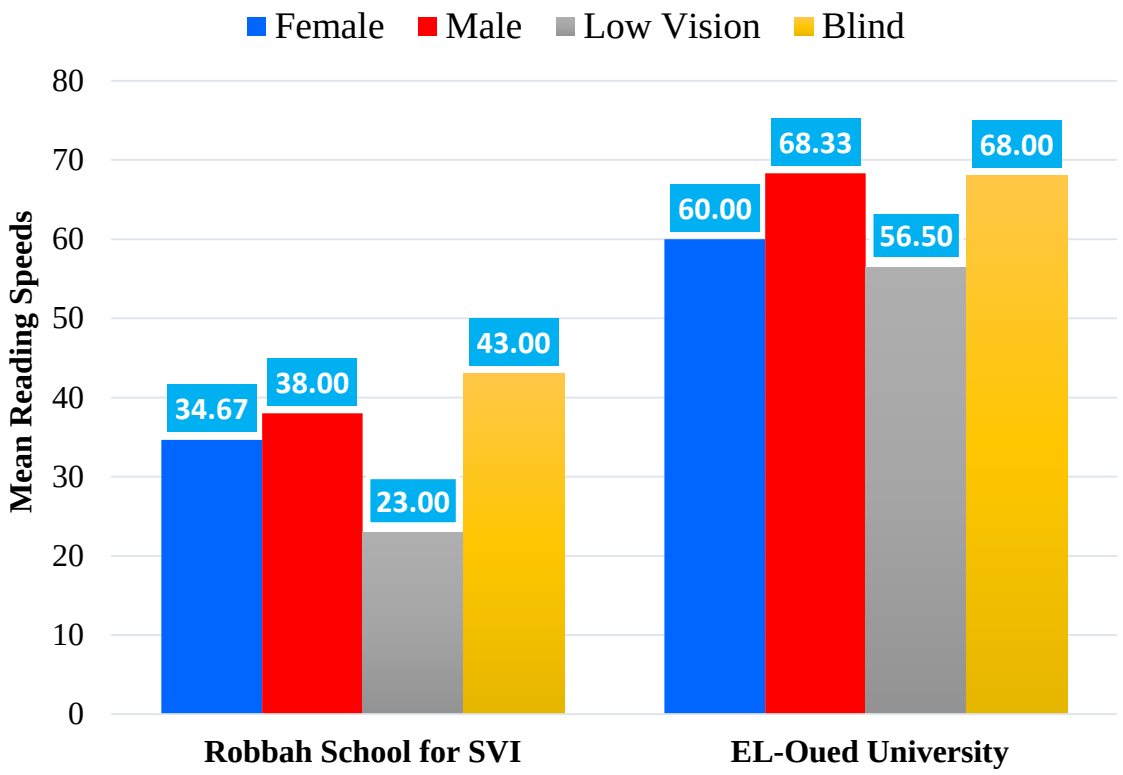


Figure illustrates that the sample of visually impaired learners from EL-Oued achieved significant average reading scores in the post-test phase. Regarding gender, the mean reading speed for males was 68.33 wpm and 60.00 wpm for females. Furthermore, the mean for low-vision students was 56.50, while for blind students was 68.00. In contrast, the sample of visually impaired pupils of Robbah School for SVI had poor performance in rates of reading English. The average females was 34.67, while for males, it was 38.00. Besides, the average low vision pupils was 23.00, while for blind pupils was 43.00.

Chapter Summary

This chapter contained the analysis and discussion of data gathered from the semi-structured interviews with the participants and pre and post-tests. Data were tabulated and displayed through tables to identify and discern any patterns that best interpret the study results.

For analyzing qualitative data, thematic analysis was used to identify and interpret patterns of meaning across the data of the in-depth interviews. To test the research hypotheses, the investigator used statistical t-tests to determine if there was a significant difference between the means of the two paired and independent samples.

CHAPTER FIVE: CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS

CHAPTER FIVE: CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS

Introduction

This chapter reviews the major findings of this study in the context of what was already known from previous studies. Next, the researcher provided the implications of the current research, recommendations, and suggestions for future research concerning the topic under investigation.

5.1.General Conclusion

Education is a fundamental human right for sighted and blind or partially sighted individuals. However, it is crucial to achieving success and quality education for all learners, irrespective of their differences. From a practical perspective, this research offers opportunities to understand students' experience with visual impairment using assistive technology.

Concerning the use of AT, the finding showed that SVI from Robbah school were not provided with appropriate assistive technology resources. Accordingly, using AT tool was exclusively related to only one type of low-tech assistive technology device. These tools were the slate and stylus. However, these tools allowed SVI to access English content by reading or writing. These low-tech did not improve the levels of SVI in mastering these skills while learning English. In contrast, SVI at EL-Oued University had a positive attitude toward screen readers to enhance listening and writing skills.

The interviews allowed a better understanding of how assistive technology impacts SVI's TEFL. The emerging themes showed that various factors influenced decisions about AT tools VI learners should use for English learning. Technology choices typically depend on

visual impairment (low vision or blindness). Besides, this decision relates to the availability of AT in the educational setting for SVI (inclusive or special educational institutions).

Furthermore, the participants in this study reported several issues and difficulties in using AT in the context of the TEFL class. Consequently, lack of training in using AT devices, their high cost, and lack of knowledge of the various continuum of these resources were the major problems affecting the efficiency, efficacy, and satisfaction in using assistive technologies.

Furthermore, this investigation indicated that facilitating access to the English curriculum, improving VI learners' confidence, and increasing language skills proficiency and independence were the most shared impact of using AT among VIS. Beyond these results, exposure to adequate assistive technologies may increase SVI efficiency in EFL learning and diminish high dependence on the knowledge of sighted individuals. However, there is no denying that there is no one-size-fits-all approach to choosing assistive technology. What works for one person may not work for another. Consequently, understanding the relationship between the components of Rogers' Innovation Diffusion Theory is essential in evaluating the impact of AT use.

This study has explored the understanding of students with VI in using AT in the TEFL. In simple terms, their experiences on the impact of AT devices they need to participate and learn in EFL at higher education (inclusive) or special (separated) educational institutions were valuable. In accordance with previous studies on the benefits of assistive technology, the results showed that AT devices reduce the barriers preventing persons with VI from functioning effectively in EFL learning and teaching fields.

Participants expressed the significant impact of AT implementation on their educational achievement in English learning. First, all the visually impaired from EL-Oued University

participants who mainly use smartphone apps for VIS recognized that increased independence was the most common benefit of AT, specifically in overcoming restrictions of dependent on their sighted peers' assistance.

In contrast, SVI from Robbah School regarded using AT devices (Braille materials) have no significant impact on enhancing their reading and writing skills. This finding was because these tools represent the low-tech level of assistive technology and do not aim to improve access and participation. Instead, this was because these devices (the slate and stylus) are low-priced equipment costing less than mid-tech or high-tech AT tools.

Improving reading speed was the essential outcome of AT use in English learning. VI learners agreed that using a screen reader increased their English accuracy. Moreover, according to them, this application could enhance their accessibility of English electronic materials in different modes such as audio format.

5.2. Major Findings

The researcher employed semi-instructed interviews and quasi-experiment as data-gathering tools to answer the research questions. Accordingly, the obtained quantitative and qualitative findings answered the following questions:

Research Question 1. Based on visually impaired students' perspectives, what assistive technology tools are used for EFL learning?

Using Braille material was the dominant assistive technology facility available for almost visually impaired students in the special educational setting (Robbah School for SVI). During their EFL class, the assertions from the participants clearly showed that the assistive technology available to students with visual impairment are Braille slate and stylus. However, almost all VI participants of this school praised this device; it represents the low level of the

assistive technology continuum. On this basis, Braille equipment was insufficient to improve their reading and writing skills.

Findings revealed that mid and high-assistive technology devices were unavailable for SVI to use for learning the English language. Yet, these levels of AT continuum were items that each VI learner needed to use; they were devices that could not be accessed. This situation implies a shortage in the mid-tech and high-tech AT resources used in Robbah School for SVI. Consequently, SVI depended exclusively on the Braille system for reading and writing as a fact on an option for learning English as a foreign language.

Compared to university students with visual impairment, access to a different level of AT tools was available. Using their mobile phones played a significant role in enhancing their experience in English learning. Interestingly, the purpose behind using these items was different. Learners with low vision tended to depend on mobile phones to improve their listening skills. In contrast, blind students used various applications to enhance the quality of their writing skills and the legibility of English written tasks.

Research Question 2. According to visually impaired students' experiences, what challenges did they face while using modern assistive technology for English learning?

The replies of VI interviewees from Robbah school exemplified challenges using Braille slate and stylus. These difficulties were crucial for device choice and utilized during their English class.

First, there was a lack of collaboration between the institutional context and the English teacher. This situation was due to the shortage of this school policy that governs regulations in this school. This latter restricted the use of school purchased AT to use in the school. Moreover, preventing visually impaired pupils from taking their Braille material constrained the use of ATs. It was evident that most case study interviewees were frustrated because of this limitation.

Thus, this situation could decrease English skills in general and writing and reading skills in particular.

For SVI from EL-Oued University, the social context was also vital for enhancing these skills. However, they illustrated that visually impaired learners' educational settings restricted their listening, reading, and writing skills to a limited extent. Then, they considered the skills and abilities of other individuals were needed to assist them fundamentally. According to them, practicing English with non-native students could be a waste of time because they would be non-competent to use English adequately.

An additional cause of concern was the unavailability of technical assistance. Screen readers are unable to access the capabilities of some ATs and hence miss out on talkback. Certain screen-touch functions on VI students' smartphones were not integrated with the screen reader, restricting interaction with the device for those with VI. For instance, learners stated that they couldn't always get guidance from their "Google Translate" transcribers since they didn't understand how to utilize various ATs.

Moreover, the results of the investigation suggested that a lack of understanding about how to obtain assistive technologies was a major obstacle. This outcome aligns with findings by UNESCO (2019), WHO (2011), and Ampratwun et al. (2016) that persons with disabilities, even those with VI, have a lack of access to and awareness of the advantages of assistive devices.

However, Although the participants attempted to be authentic in their perspectives on assistive technology encounters, they emphasized the issue of accessibility and technological shortcomings. In this context, the participants' evaluations suggested that their levels of proficiency in a range of assistive technology competencies were much lower than what was expected to be shown by the literature review's findings to fulfill the requirements of educating

visually impaired students. Therefore, a lack of training on using those technologies yielded a limited chance for VI students to benefit from them. Such findings seem to support the argument that the gap in these teachers' knowledge and skills is crucial in SVI's inefficient use of assistive technology.

Research Question 3. Does using printed Braille paper or an electronic Braille display significantly impact the reading speed of English among visually impaired students at EL-Oued University?

Based on these results, the difference between the average reading speed using an electronic Braille display ($M = 64.17$, $SD = 8.612$) was significantly greater than the average reading speed rate using Braille paper among visually impaired learners at EL-Oued University ($M = 56.83$, $SD = 8.495$), $t(5) = -22.0021, p = 0.000003603$.

Research Question 4. Does using printed Braille paper or an electronic Braille display significantly impact the reading speed of English among visually impaired students at Robbah School for SVI?

Based on these results, the difference between the average reading speed using an electronic Braille display ($M = 36.33$, $SD = 13.337$) was significantly higher than the average reading speed rate using Braille paper among visually impaired learners at Robbah School for SVI ($M = 51.33$, $SD = 12.956$), $t(5) = -5.78, p = 0.00218$.

Research Question 5. Does the use of an electronic Braille display have any significant difference between visually impaired students at Robbah School for SVI and visually impaired learners at EL-Oued University on the reading speed of English?

Therefore, there is enough evidence to claim that the 1st population average ($\mu 1$) ($M = 36.33$, $SD = 13.337$) is significantly different than the 2nd population average ($\mu 2$) ($M = 64.17$, $SD = 8.612$), $t(10) = -4.295$, $p = 0.0016$ at the $\alpha = 0.05$ significance level. These results indicate

that the mean sample of visually impaired students at Robbah School for SVI was not equal to the average of the case of visually impaired students at EL-Oued University. Hence, this study showed a noticeable improvement in the reading speed of VIS at EL-Oued University using an electronic Braille display.

5.3.Implications for the study

The present study's findings provided theoretical and practical implications for those concerned with the field of visually impaired students' education, especially for EFL teachers. The implications are as follows:

1. This study showed the value of understanding the perspectives of visually impaired students, which deserves more attention. Their English language learning experiences may be ignored unintentionally, and their needs may not be fully addressed appropriately.
2. In the absence of sufficient support to learn English efficiently, the lack of availability of appropriate educational tools was an issue for visually impaired learners. Then, this research illustrated how this factor was crucial in access to visual or printed information.
3. The study indicated that reading speed is essential for students with visual impairment in English learning. Thus, teaching reading by assessing their limitations and determining the adequate assistive technology tool could enhance their levels.
4. Additionally, the lack of knowledge about assistive technology applications and devices was not limited to SVI. This research tackled the importance of raising the awareness of TVIs and sighted peers of VIS. This factor would facilitate more interactions during the learning process.

5. Assistive technology is more than just an educational tool. It could be used to develop emotional, cultural, and social values among the students.
6. The findings of this study showed evidence that not one assistive technology device fits all. Then, this inquiry revealed the need to assess the educational needs of students with visual impairment.
7. The results of this study demonstrate that there was a need to create a clear policy in inclusive and special educational institutions to promote the quality of learning for visually impaired learners.

5.4.Recommendations

Based on the findings, the following recommendations include significant considerations to improve the teaching of reading English for visually impaired learners using assistive technology resources like refreshable Braille displays.

1. Teachers of visually impaired students should simplify the content of the EFL curriculum where Robbah School for SVI and EL-Oued University fail to provide the needed support for teaching reading English for VI learners.
2. In inclusive educational settings for visually impaired learners, it is essential to consider the skills and abilities of the sighted individuals who will be ready to assist VI learners as needed.
3. Providing a range of support services, including trial periods, is essential to ensure that the AT system is suitable for the AT user (visually impaired students).
4. Providing appropriate and practical training for SVI to use assistive technology resources is vital in ensuring equity in access to education.
5. Provide reading materials to the teacher of students with visual impairments in advance to be enlarged, scanned, Brailled, or recorded on tape.

6. Textbooks and books used in educational settings should be available on recorded tapes and provided to visually impaired students before explaining English lessons or lectures.
7. The appropriate font size and optical assistive technology devices to read printed materials should be available for low-vision students.
8. The English texts should be inputted into an electronic Braille note-taker and then translated into a print copy for visually impaired students and their teacher.

5.5.Suggestions for Future Research

These suggestions below are based on the promising findings presented in this study for future research.

1. The sample size is small. Accordingly, the generalization of the result is restricted to only the population of visually impaired students of the Braille Club at of EL-Oued University and Robbah School for SVI. Thus, it would be more interesting if future research included larger samples.
2. Concerning reading speed, an in-depth exploration of how AT use impacts reading fluency, comprehension, and accuracy of English among visually impaired students would be beneficial in evaluating AT usability.
3. It would also be helpful to capture qualitatively the experiences and perspectives of SVI experiences using non-participant observations. Similarly, further research might involve exploring the experiences of English teachers of learners with sight loss.
4. Being exploratory and pragmatic research raises many opportunities for future research in theory development and concept validation. This can be carried out in a longitudinal study to investigate the phenomenon of interest profoundly.

Conclusion

In summary, this chapter outlined the main conclusions drawn from the current research results. Furthermore, this chapter presented the study's implications, recommendations, and suggestions for further research. It can be concluded that using assistive technology tools may hold promise for significantly impacting teaching reading English for visually impaired learners. However, matching those students with the appropriate assistive products and technologies requires understanding the relationship between the five attributes that affect using technological intervention: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5), observability.

In this context, limited published evidence has been documented on AT use in teaching English as a foreign language (TEFL) to visually impaired students. Therefore, Therefore, additional research is needed to understand how the use of assistive technologies impacts the EFL learning experience of students with visual impairment. Such research may not only enhance knowledge in the field of TEFL but also be essential for the process of assistive technology assessment.

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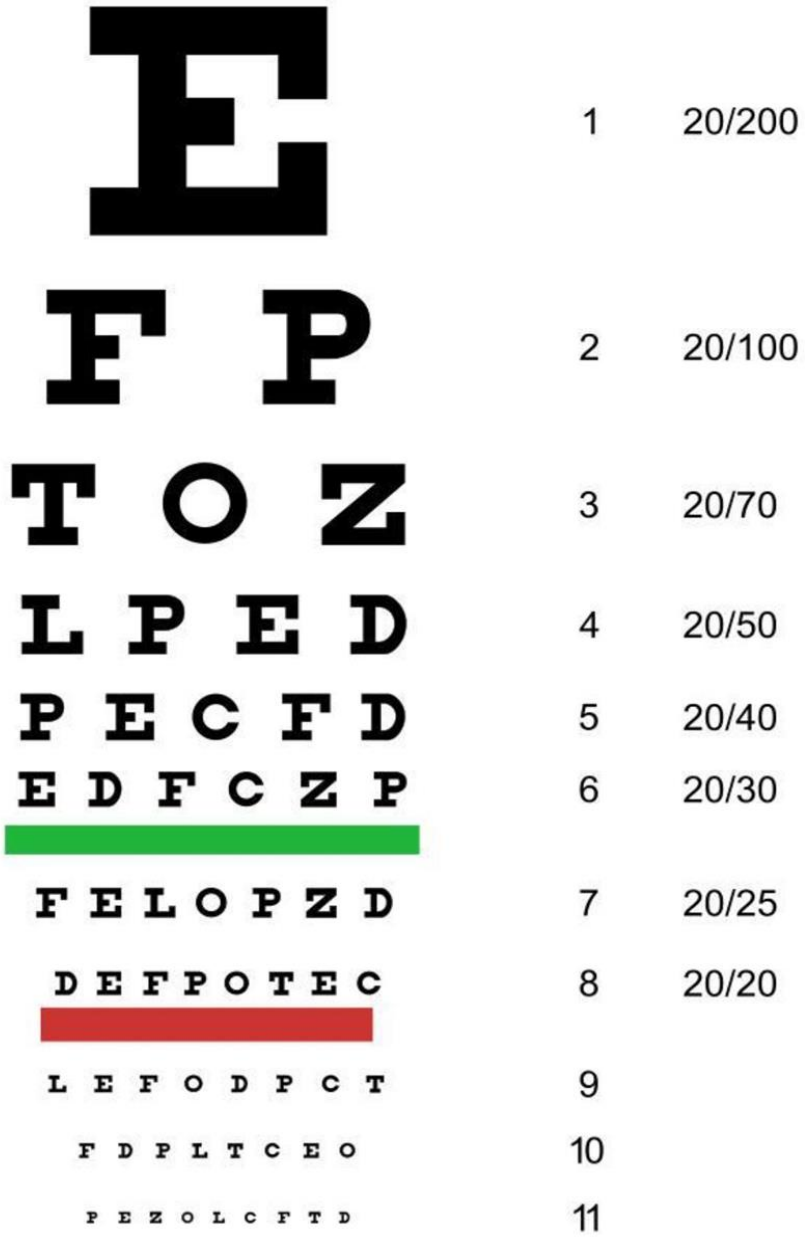
&ved=2ahUKEwjVo6rvkeL6AhU-
S_EDHTryCNUQFnoECA4QAQ&url=https%3A%2F%2Fcore.ac.uk%2Fdownload%2Fpd
f%2F37320862.pdf&usg=AOvVaw0hrxsU5claMmdO9Nvz-m6I

Appendix A: Snellen Eye Chart



Source. Messina and Evans (2006, p. 3).

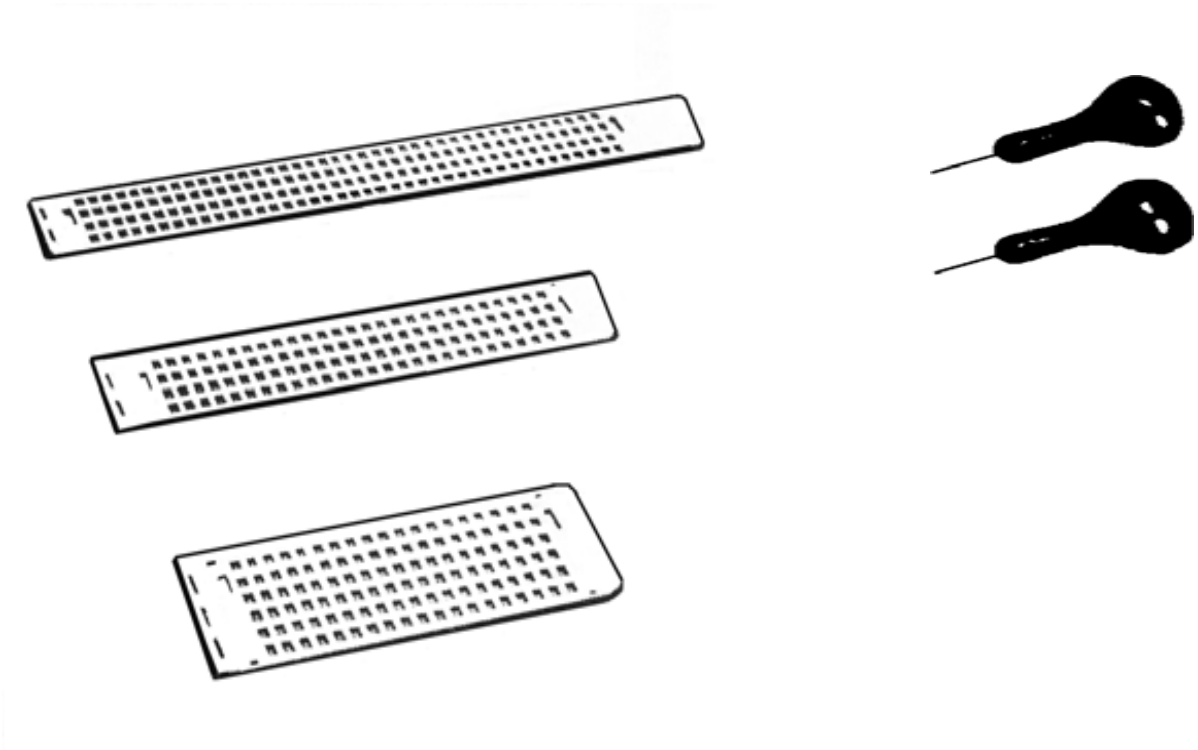
Appendix B: Common Eye Conditions Causing Vision Impairment

	**Age-related macular degeneration** Damage to the central part of the retina responsible for detailed vision leads to dark patches, shadows or distortion of the central vision. The riskof developing macular degeneration increases with age.
	**Cataract** Cloudiness in the lens of the eye, leading to increasingly blurred vision. Therisk of developing cataract increases with age.
	Corneal opacity A group of conditions causing the cornea to become scarred or cloudy. Opacity is most commonly caused by injury, infection or vitamin A deficiency in children.
	**Diabetic retinopathy** Damage to blood vessels in the retina which become leaky or blocked. Vision loss most commonly occurs due to swelling in the central part of the retina which can lead to vision impairment. Abnormal blood vessels can also grow from the retina, which can bleed or cause scarring of the retina and blindness.
	**Glaucoma** Progressive damage to the optic nerve. Initially, loss of vision occurs in the periphery and can progress to severe vision impairment (this is known as open angle glaucoma, the most common type and the type generally referred to in this report).
	**Refractive error** Due to an abnormal shape or length of the eye ball; light does not focus on the retina resulting in blurred vision. There are several types of refractiveerror; those most commonly referred to in this report are: - *Myopia* – difficulty seeing distant objects (near-sightedness). - *Presbyopia* – difficulty seeing objects at near distance with increasing age(i.e. after 40 years of age).
	**Trachoma** Caused by a bacterial infection. After many years of repeated infections, the eyelashes can turn inwards (known as trichiasis) which can lead to corneal scarring and, in some cases, blindness.

Source. World Health Organization (2019, p.7)

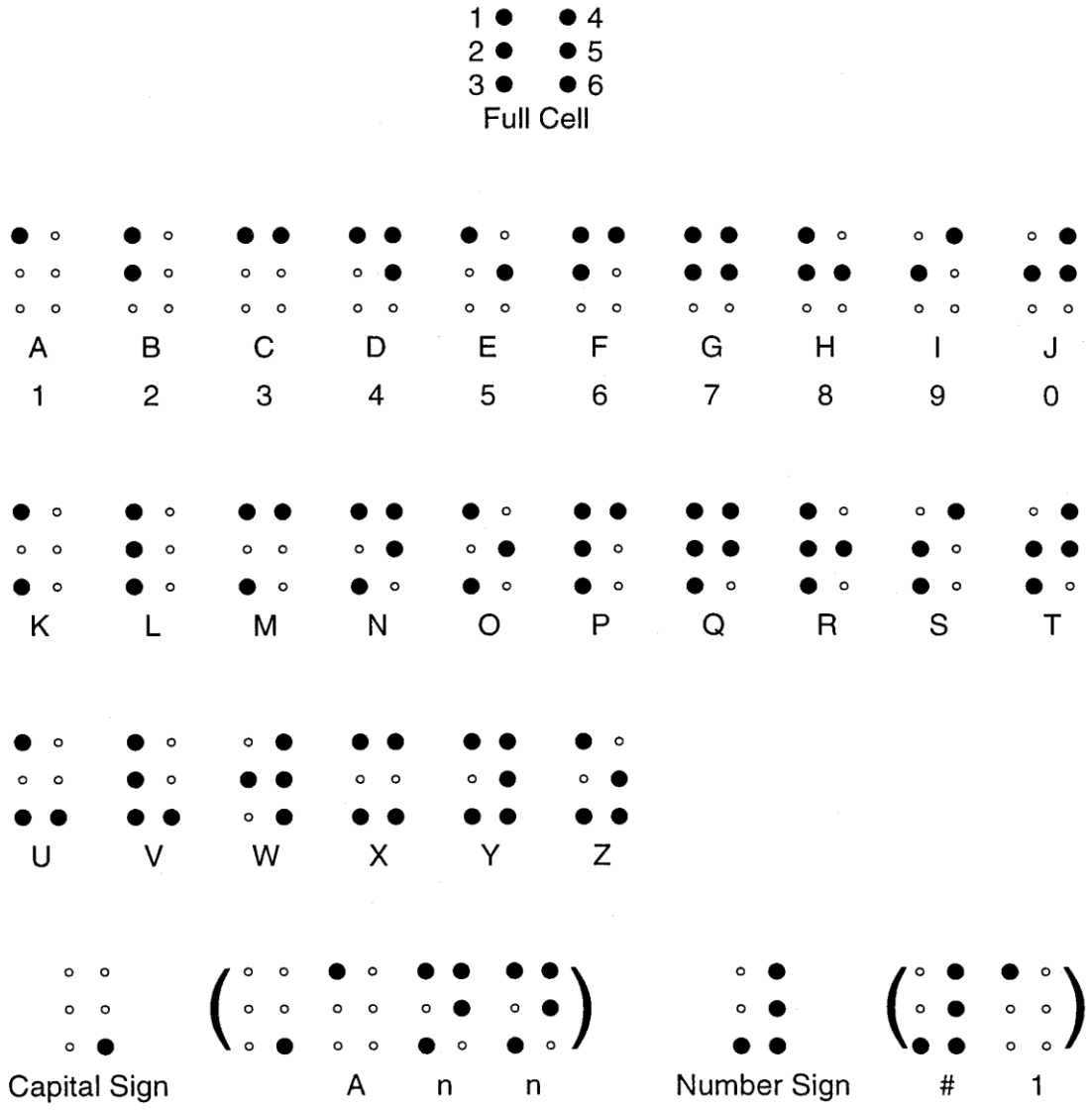
Appendix C. Slate and Stylus

Pocket Slate **Pencil Stylus**



Source. Carney, Engbretson, Scammell, and Sheppard (2003, p. 94)

Appendix D: Braille Alphabet and Numbers



Source. Morgan (1995, p. 1125)

Appendix E: Assistive Technologies for Low Vision and Blindness

	Type	Product	Company
Low Vision	Magnifying software	ZoomText	AiSquared
		BigShot	AiSquared
		Dual with Solo	Claro
		Lunar	Dolphin
		SuperNova	Dolphin
		MAGic	FreedomScientific
		iZoom 1.2, iZoom2Go	Issist
		VisioVoice (Mac)	Origin Instruments
		Lighting	Sensory Software
	Magnifying hardware	QuickLook	Ash Technologies
		Fusion	Ash Technologies
		Liberty	Ash Technologies
		OPTi Verso (distance)	Ash Technologies
		Prisma	Ash Technologies
		Optic magnifiers	Bausch & Lomb; Eschenbach
		Clarity Series (distance), i-vu	Clarity
		Acrobat, Amigo, Flipper, Jordy, Max	Enhanced Vision Systems
		Topaz	FreedomScientific
		Opal	FreedomScientific
		SenseView	GWMicro
		MyReader	HumanWare
		SmartView	HumanWare
		MagniLinkS OCR (distance, scanning)	LVI
		Compact	Optelec
		ClearView	Optelec
		Traveller	Optelec
		ClearNote (distance)	Optelec
		Optron, I-stick (distance)	Optron
		MonoMouse, ColorMouse	Sensory Software
		Shoppa, BigReader	Sensory Software
		View series (distance)	Vision Technology

	Type	Product	Company
Blindness	**Braille writers/PDAs**	PacMate, Type Lite	FreedomScientific
		Braille Lite, Braille'n'Speak	FreedomScientific
		BrailleSense	GW Micro
		Small-Talk	GW Micro
		Braillino	Handy Tech
		BrailleNote	HumanWare
		VoiceNote	HumanWare
		Maestro	HumanWare
		EasyLink	Optelec
		Mountbattern Brailler	Quantum Technology
		TatraPoint	Bronislav Mamojka
		Perkins Brailler	Howe Press (Perkins)
	Screen Readers	Hall	Dolphin
		Jaws	FreedomScientifc
		Window-Eyes	GW Micro
		Thunder-RJ	RJ Cooper
		Lifestyle, the System Access Mobile Network	Serotek
	Refreshable Braille Displays	Vario	BAUM
		Focus	FreedomScientific
		Braille Star	Handy Tech
		Handitech	Handy Tech
		Braille Wave	Handy Tech
		Brailliant	HumanWare
		Alva	Optelec
		Delphi	Optelec
		Voyager	Optelec
		Elba	Papenmeier
		BRAILLEX	Papenmeier
	Braille printers (embossers)	Braille BookMaker, Marathon	Enabling Technologies
		Braille Express	Enabling Technologies
		BraillePlace	Enabling Technologies
		Juliet, ET, Romeo	Enabling Technologies
		Triple Impressions	Enabling Technologies
		Braille Blazer	FreedomScientific
		Basic S/D, 4x4 Pro, Everest	Index Braille

		Product	Company
Blindness		Gemini embosser (Braille+print)	Nippon Telesoft
		Versa Point	TeleSensory Corporation
		Emprint (Braille+print), ViewPlus Pro, Cub, Max	ViewPlus
	Audio tactile	InteliKeys	Cambium Learning Technologies
		Talking Tactile Tablet	Touch Graphics
		IVEO	ViewPlus
	Electronic text readers	BookPort (discontinued)	APH
		ScannaR	Baum Retec
		Milestone 311/312	Bones
		Cybook	Bookeen
		Cicero	Dolphin
		Sara	FreedomScientific
		MobilEyes	Guerilla Technologies
		Bookworm	HandyTech
		Victor Reader, Vibe, ClassicX, Stream	HumanWare
		K-NFB Reader	Kurzweil – NFB
		Plextalk Series	Plextor
		BookCourier	Springer Design
	Reading/scanning software	EasyReader	Dolphin
		EasyProducer	Dolphin
		OpenBook	FreedomScientific
		FSReader	FreedomScientific
		Kurzweil 1000	Kurzweil Educational Systems
		TextAloud	NextUp
		Text-to-Audio, ScanPro	Premier Assistive Technology
		INFORM	Sensory Software
	GPS	StreetTalk	FreedomScientific
		Trekker / Breeze GPS	HumanWare
		BrailleNote GPS	HumanWare
		Mukana	Slashphone
		Wayfinder Access	Wayfinder

	Type	Product	Company
	Text-to-Braille translation software	Braille Maker	Cragside AccessABILITY Ltd
		Braille Music Translator suite	Dancing Dots
		Duxbury, Perky Duck	DuxburySystems
		MegaDots	DuxburySystems
		WinBraille	Index Braille
		iBraille for Mac	Index Braille
		OpusDots Lite	Opus Technologies
		Monty	Quantum Technology
		Braille Master	Robotron
		KWIKBRL	Sensory Software
	Type	Product	Company
CVI	Port. Writers	Alphasmart, Neo	Alphasmart
		Fusion, Writer	Advanced Keyboard Technologies, Inc.
	E-text reader	ClassMate Reader	HumanWare

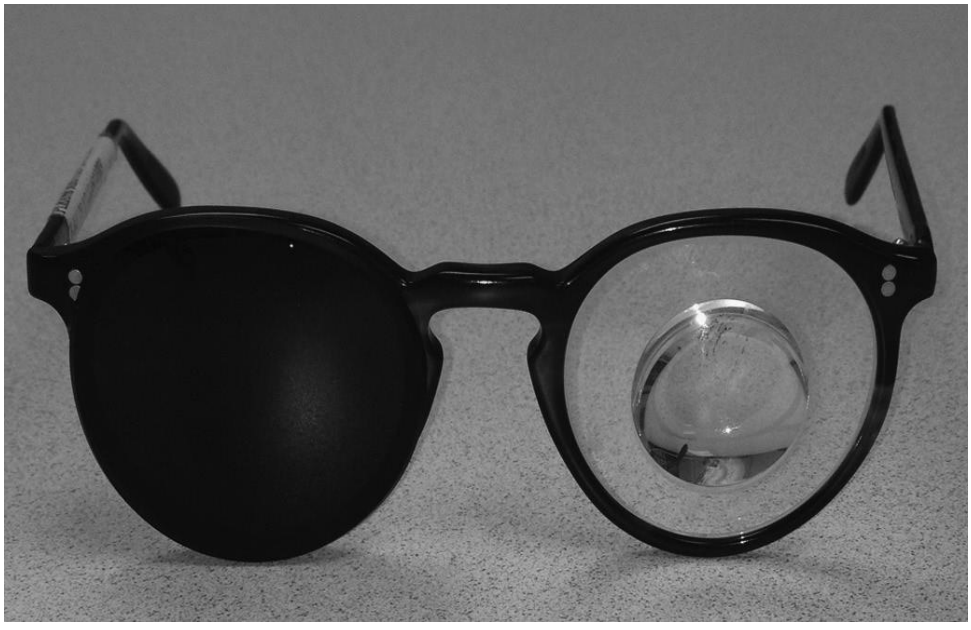
Source. Reed (1995, pp. 24-27).

Appendix F: Optical Magnifiers

a) Hand-Held Magnifier

Source. Manduchi and Kurniawan (2018, p. 65).

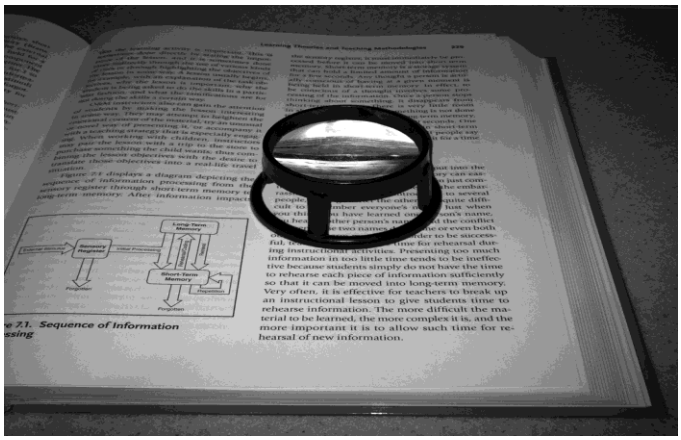
b) Spectacle Microscope



Source. Manduchi and Kurniawan (2018, p. 65).

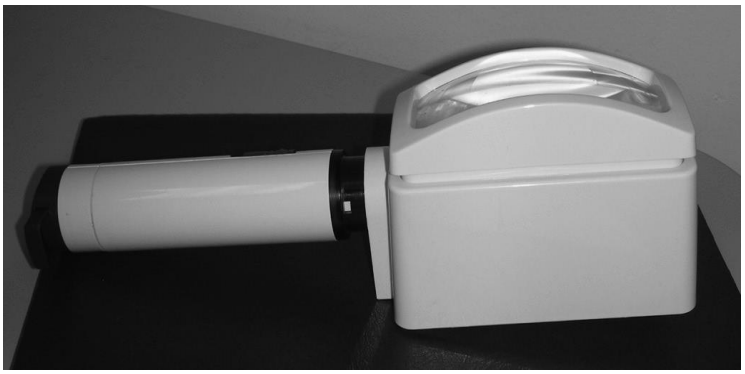
Continued

c) Stand Magnifier



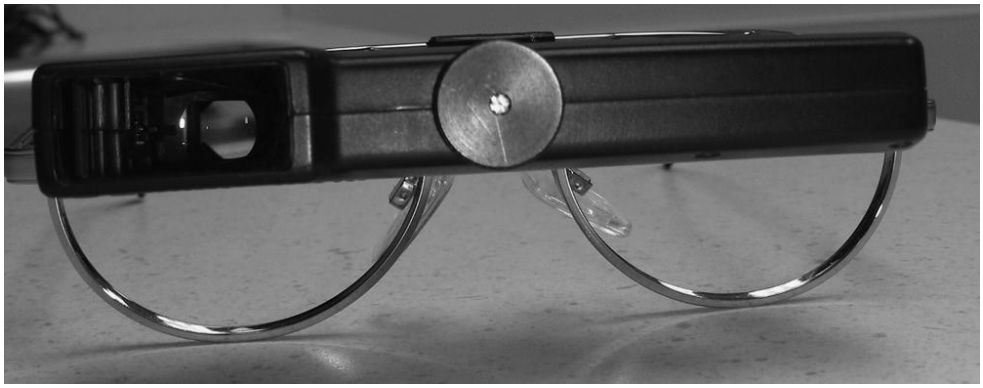
Source. Manduchi and Kurniawan (2018, p. 66).

d) Illuminated Stand Magnifier



Source. Manduchi and Kurniawan (2018, p. 66).

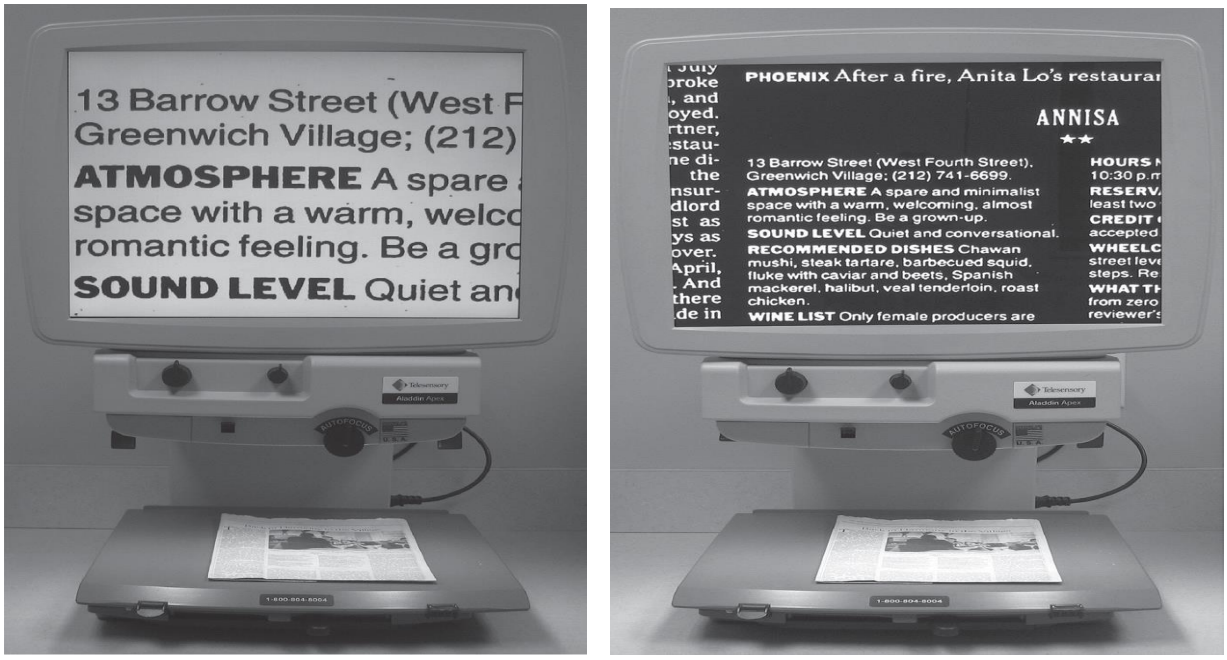
e. Telemicroscope



Source. Manduchi and Kurniawan (2018, p. 66)

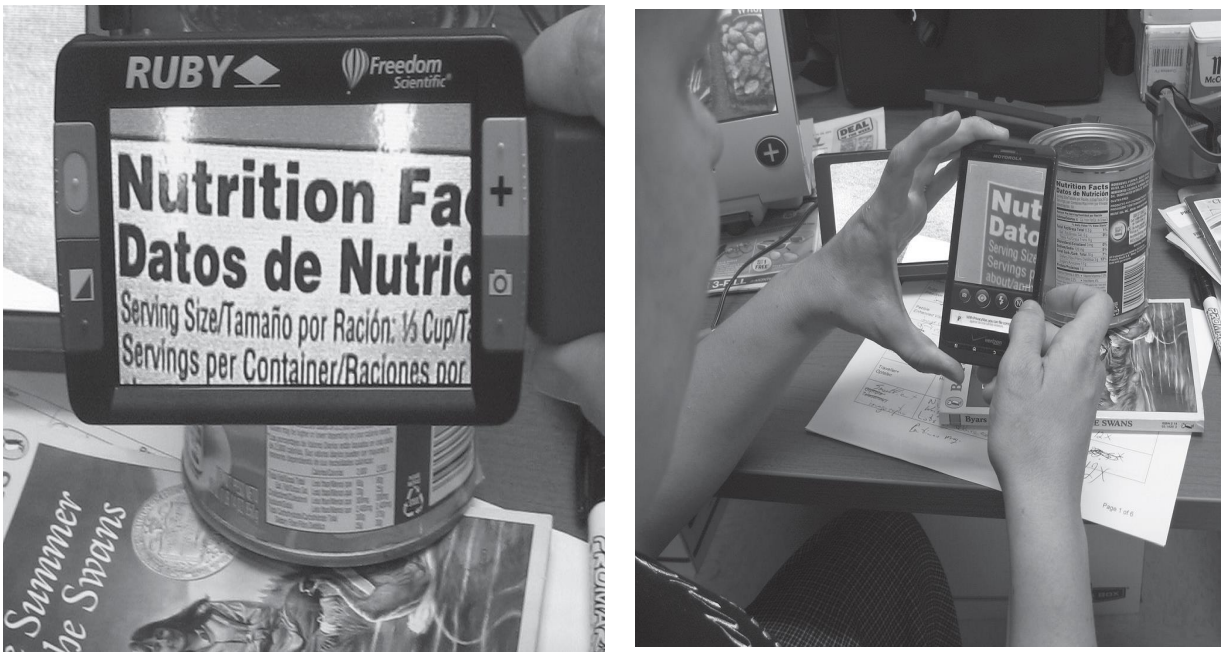
Continued

f. Closed Circuit Television



Source. Manduchi and Kurniawan (2018, p. 70)

e) Video Magnifier



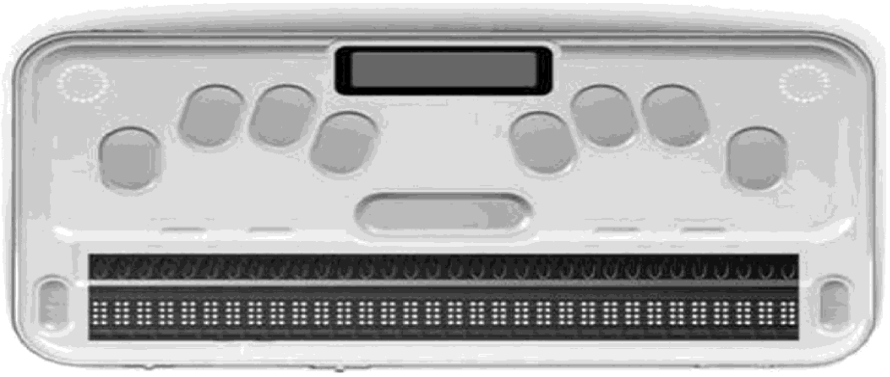
Source. Manduchi and Kurniawan (2018, p. 71)

Appendix G: Braille Notetaker Display Products

a) Braille Sense OnHand with GPS Receiver

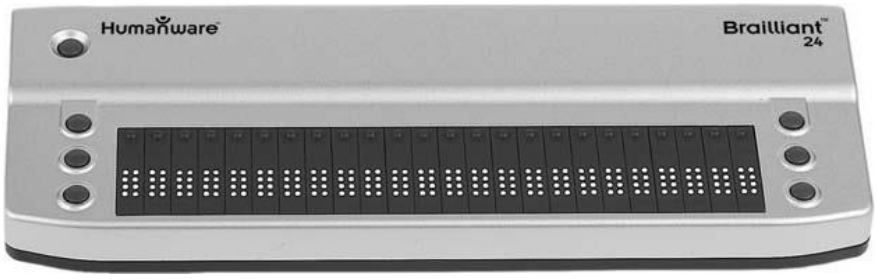
Source. Manduchi and Kurniawan (2018, p. 89)

b) Braille Sense Notetaker



Source. Manduchi and Kurniawan (2018, p. 89)

c) HumanWare's Brailliant Refreshable Braille Display



Source. Robitaille (2010, p. 36)

Appendix H: The Braille Sense Notetaker Used in the Study

Appendix I: Informed Consent Form

Purpose of the Study

This study intends to understand visually impaired students' experiences on "The Impact of Using Assistive Technology on Reading Speed Rate of English as a Foreign Language among visually impaired students." The data collected in this research will be used to help the researcher Miss. Soumia TAMMA to gain insight into the phenomenon under investigation. This research will be submitted in partial fulfillment of the requirements for the degree of "Doctorate" Third Cycle LMD at Batna 2 University.

Subject's Understanding:

- I understand that my participation is voluntary and that I can withdraw at any time without giving any reason or adverse repercussions.
- I agree to participate in a face-to-face interview that is expected to take no more than 40 minutes with the interviewer Soumia TAMMA.
- I understand that this interview will be tape-recorded.
- I understand that the audio recording made of this interview will be used only for data analysis.
- I understand that all data collected will be limited to any use related to the research purpose authorized by the researcher.
- I understand that my identity will not be disclosed in any publications or presentations that report the findings of this study.
- I understand that my responses will be kept strictly confidential. I understand that my name will not be linked with the research materials and will not be identified or identifiable in the report or reports that result from the research.
- I am aware that all audio records will be kept confidential in the secure possession of the researcher.

Subject's Agreement:

I acknowledge that I have read and understand the above information. I agree to take part in this interview.

Signature of Respondent (Verbal Assent)

Signature of Interviewer

Appendix J: Informed Consent Form (Translated)

تهدف هذه الدراسة إلى فهم خبرات الطلاب حول "تأثير استخدام التكنولوجيا المساعدة على نسبة سرعة قراءة الانجليزية كلغة اجنبية للمتعلمين ذوي القصور البصري". يتم استخدام البيانات التي تم جمعها في هذا البحث لاستخلاص النتائج لمساعدة الباحثة الآنسة: سمية تامة في اكتساب نظرة ثاقبة للظاهرة قيد التحقيق.

فهم المستجوب ل:

- أوافق على المشاركة في هذه الدراسة التي أفهم أنها ستقدَّم في تحقيق جزئي لمتطلبات درجة "الدكتوراه" الطور الثالث LMD في جامعة باتنة 2.
- أفهم أن مشاركتي طوعية.
- أوافق على المشاركة في مقابلة وجهًا لوجه والتي من المتوقع ألا تستغرق أكثر من 40 دقيقة مع المحاور سمية تامة.
- أفهم أن المقابلة ستكون مسجلة بالصوت فقط.
- أفهم أن جميع البيانات التي تم جمعها ستقتصر على أي استخدام متعلق بغرض البحث المصرح به من قبل الباحث.
- أفهم أنه لن يتم الكشف عن هويتي في أي منشورات أو عروض تقديمية تقدم نتائج هذه الدراسة.
- أدرك أن جميع التسجيلات الصوتية ستبقى سرية في حوزة الباحث.
- أفهم أنه يمكنني الانسحاب من هذه الدراسة في أي وقت دون أي تداعيات سلبية.

موافقة المستجوب:

أقر بأنني قد قرأت وفهمت المعلومات الواردة أعلاه وعليه أوافق على المشاركة في هذه المقابلة.

توقيع المُستجوَب (الموافقة الشفهية)

توقيع المُحاوِر

Appendix K: Interview Questions for Visually Impaired Students

The 1st Section: Demographic Information

1) Could you please state your name, age, and educational level?
2) Could you please tell me what type of visual impairment you have?
3) How long have you been visually impaired?

The 2nd Section: Compatibility of Assistive Technology

4) What are the most frequent educational tools you use in your English learning?
5) For what purpose (s) do you use those tools in your English learning? Could you please provide examples?

The 3rd Section: Observability of Assistive Technology

6) How do you determine the tools you should use during your English learning?
7) Do your teacher and classmates estimate your AT use in the English subject? If yes, explain how. If not, how do you deal with this situation?

The 4th Section: Complexity of Assistive Technology

8) What difficulties (if any) slowed down or prevented your assistive technology use appropriately for English learning? How have you dealt with these challenges?

The 5th Section: Trialability of Assistive Technology

9) If you have not received any previous training, describe to me how you learned to manage the assistive technology device (s) use?

The 6th Section: Relative advantages of Assistive Technology

10) From your experience, how did using these tools affect your English learning? Please clarify.
11) Do you have any further comments or suggestions?

Thank you for your time and valuable contribution to this research.

Appendix L: Interview Questions for Visually Impaired Students (Translated)

القسم الأول: معلومات ديموغرافية

1) هل يمكنك من فضلك ذكر اسمك وعمرك ومستواك التعليمي؟
2) هل يمكن أن تخبرني من فضلك عن نوع ضعف البصر لديك؟
3) منذ متى وأنت تعاني من قصور في البصر؟

القسم الثاني: توافق التكنولوجيا المساعدة

4) ما هي أكثر الأدوات التعليمية استعمالا لك في تعلم اللغة الإنجليزية؟
5) (لأي غرض (أغراض) تستخدم هذه الأدوات في تعلم اللغة الإنجليزية؟ هل يمكنك تقديم أمثلة من فضلك؟

القسم الثالث: قابلية ملاحظة التكنولوجيا المساعدة

6) كيف تحدد الأدوات التي يجب أن تستخدمها؟
7) هل يقدر معلمك وزملاؤك استخدامك للتكنولوجيا المساعدة في مادة اللغة الإنجليزية؟ إذا كانت الإجابة نعم، اشرح كيف. إذا لم يكن الأمر كذلك ، كيف تتعامل مع هذا الموقف؟

القسم الثالث: درجة تعقيد التكنولوجيا المساعدة

8) ما الصعوبات (إن وجدت) التي أبطأت أو حالت دون استخدام التكنولوجيا المساعدة بشكل مناسب لتعلم اللغة الإنجليزية؟ كيف تعاملت مع هذه التحديات؟

القسم الرابع: إمكانية تجربة التكنولوجيا المساعدة

9) إذا لم تكن قد تلقيت أي تدريب مسبق ، فصف لي كيف تعلمت إدارة استخدام أجهزة التكنولوجيا المساعدة؟

القسم الخامس: تقييم المزايا النسبية للتكنولوجيا المساعدة

10) من خلال تجربتك ، كيف أثر استخدام هذه الأدوات على تعلمك للغة الإنجليزية؟ وضح رجاءا.
11) هل لديك أي تعليقات أو اقتراحات أخرى؟

شكرًا لك على وقتك ومساهمتك القيمة في هذا البحث.

Appendix M: Request for Permission from the Chef of the English Department to the Principal of Robbah School for SVI

الجمهورية الجزائرية الديمقراطية الشعبية
REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE

Ministère de L'enseignement Supérieur et de la Recherche Scientifique
Université Mostafa Benboulaid Batna 2
Faculté Des Lettres et Langues Etrangères
Département de Langue et Littérature Anglaises

وزارة التعليم العالي والبحث العلمي
جامعة مصطفى بن بولعيد باتنة 2
كلية الآداب واللغات الأجنبية
قسم اللغة و الأدب الإنجليزي

الرقم: 009/ق ل ٢.٢/ك.آ.ل.ج/ج.ب2/2019

الى السيد: مدير المدرسة الخاصة بالمكفوفين الرباح ولاية الوادي

الموضوع: طلب المساعدة في انجاز بحث الدكتوراه

لي عظيم الشرف أن أتقدم الى سيادتكم بطلبي هذا والمتمثل في تسهيل إجراءات التربص للطالبة: تامة سمية المسجلة في الدكتوراه السنة الثانية تخصص (Applied Linguistics and TEFL) في القسم المذكور أعلاه وذلك لانجاز بحثها على مستوى مؤسستكم في اطار ما يسمح به القانون.

وفي الأخير تقبلوا منا سيادتكم أسمى عبارات التقدير والاحترام.

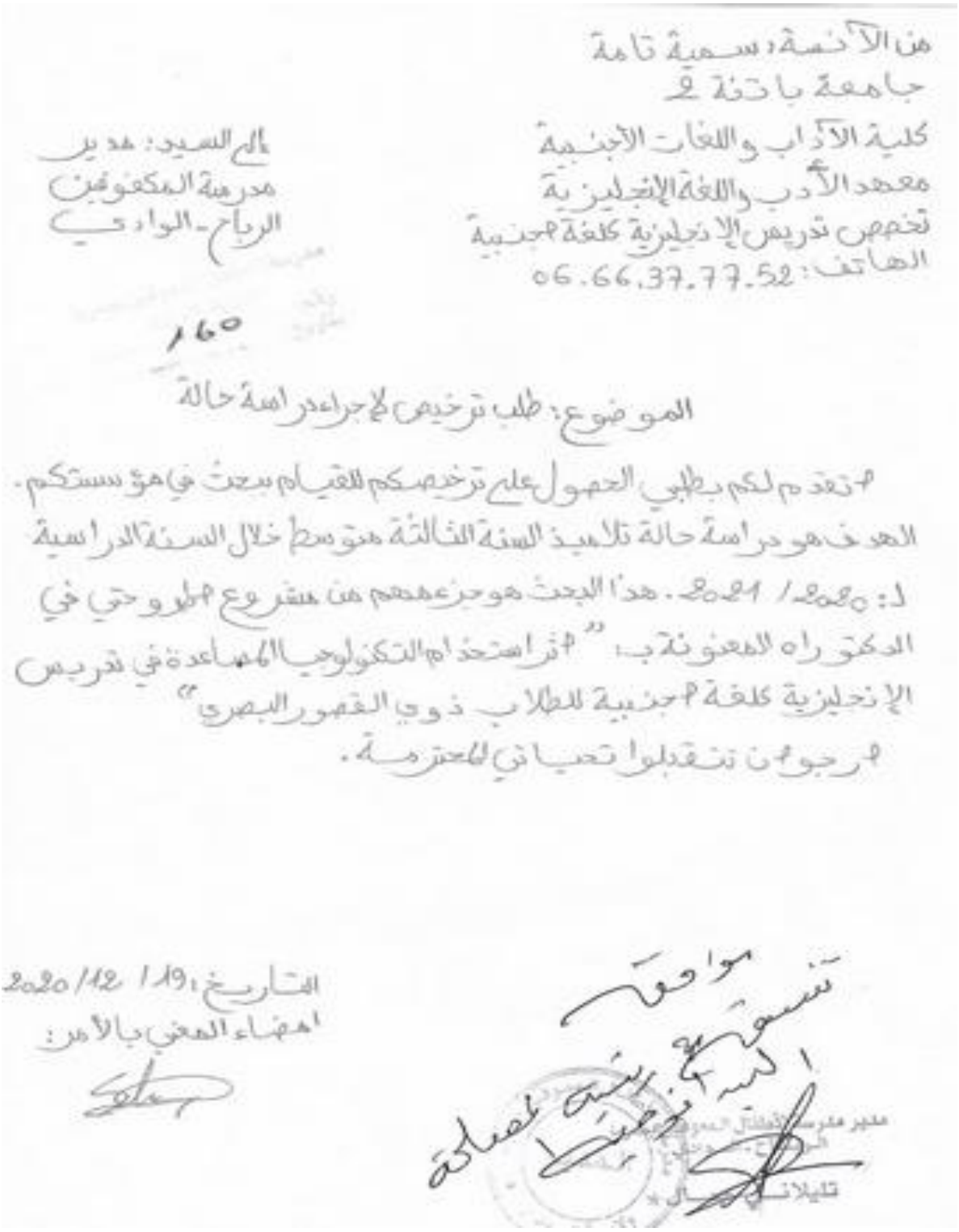
رئيس القسم

30 JAN. 2019

Département de Langue et Littérature Anglaises | Université Batna 2 N° 53, Route de Constantine. Fesdis, Batna 05078, Algérie

Appendix N: Request to the Principal of Robbah School for SVI

for Approval to Conduct Research



من الآنسة: سمية تامة
جامعة باتنة 2
كلية الآداب واللغات الأجنبية
معهد الأدب واللغة الإنجليزية
تخصص تدريس الإنجليزية كلغة أجنبية
الهاتف: 06.66.37.77.52

إلى السيد: مدير
مدرسة المكفوفين
الرباح - الوادي

160

الموضوع: طلب ترخيص لإجراء دراسة حالة

تتقدم لكم بطلبي الحصول على ترخيصكم للقيام ببحث في مؤسستكم.
الهدف هو دراسة حالة تلاميذ السنة الثالثة متوسط خلال السنة الدراسية
ل: 2020/2021. هذا البحث هو جزء منهم من مشروع أطروحتي في
الدكتوراه المعنونة بـ: "أثر استخدام التكنولوجيا المساعدة في تدريس
الإنجليزية كلغة أجنبية للطلاب ذوي القصور البصري"
نرجو منكم تقبلوا تحياتي المحترمة.

التاريخ: 2020/12/19
امضاء المعني بالأمر:

موافقة
تسهيل مهمة
مدير مدرسة المكفوفين

Appendix O: Request to the Principal of Robbah School for SVI

for Approval to Conduct Research (Translated)

From Miss: TAMMA SOUMIA
Batna 2 University
Faculty of Letters and Foreign Languages
Department of English Language and Literature
A Branche of Teaching English as a Foreign Language
Tel: 06.66.37.77.52

To the Principal of
Robbah School for SVI
Robbah, EL-Oued

Subject: A Request for Permission to Conduct a Case Study

Dear Sir,

I submit my request to obtain your permission to do research at your school. The aim is to conduct a case study of the pupils in the third year of middle school for the 2020/2021 school year. This research is an essential part of my doctoral thesis project entitled "The Impact of Using Assistive Technology on Teaching English as a Foreign Language for Students with Visual Impairments."

Please accept my respectful greetings.

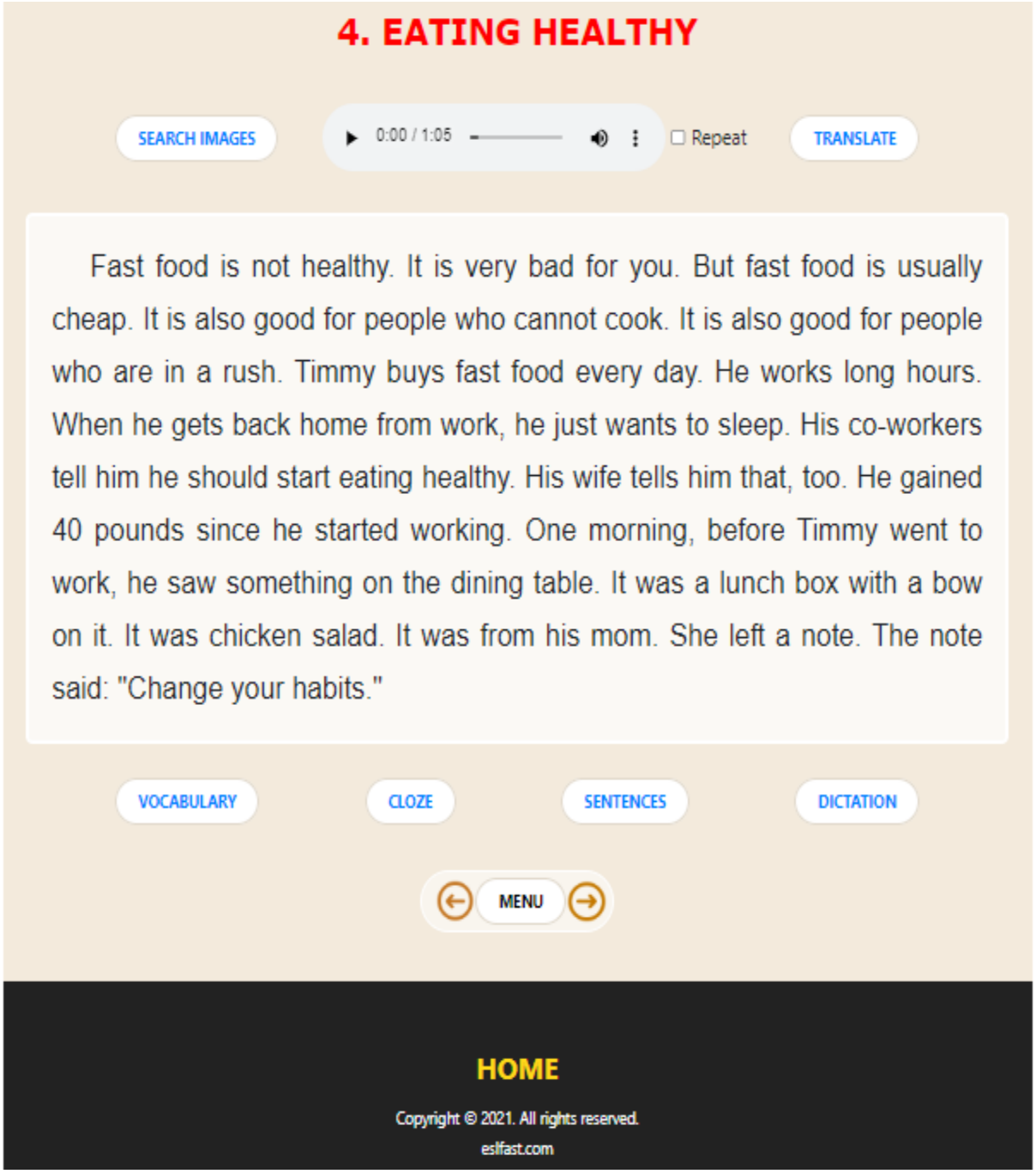
Date:

The signature of the concerned person:

Appendix P: T-Distribution Table of Critical Values

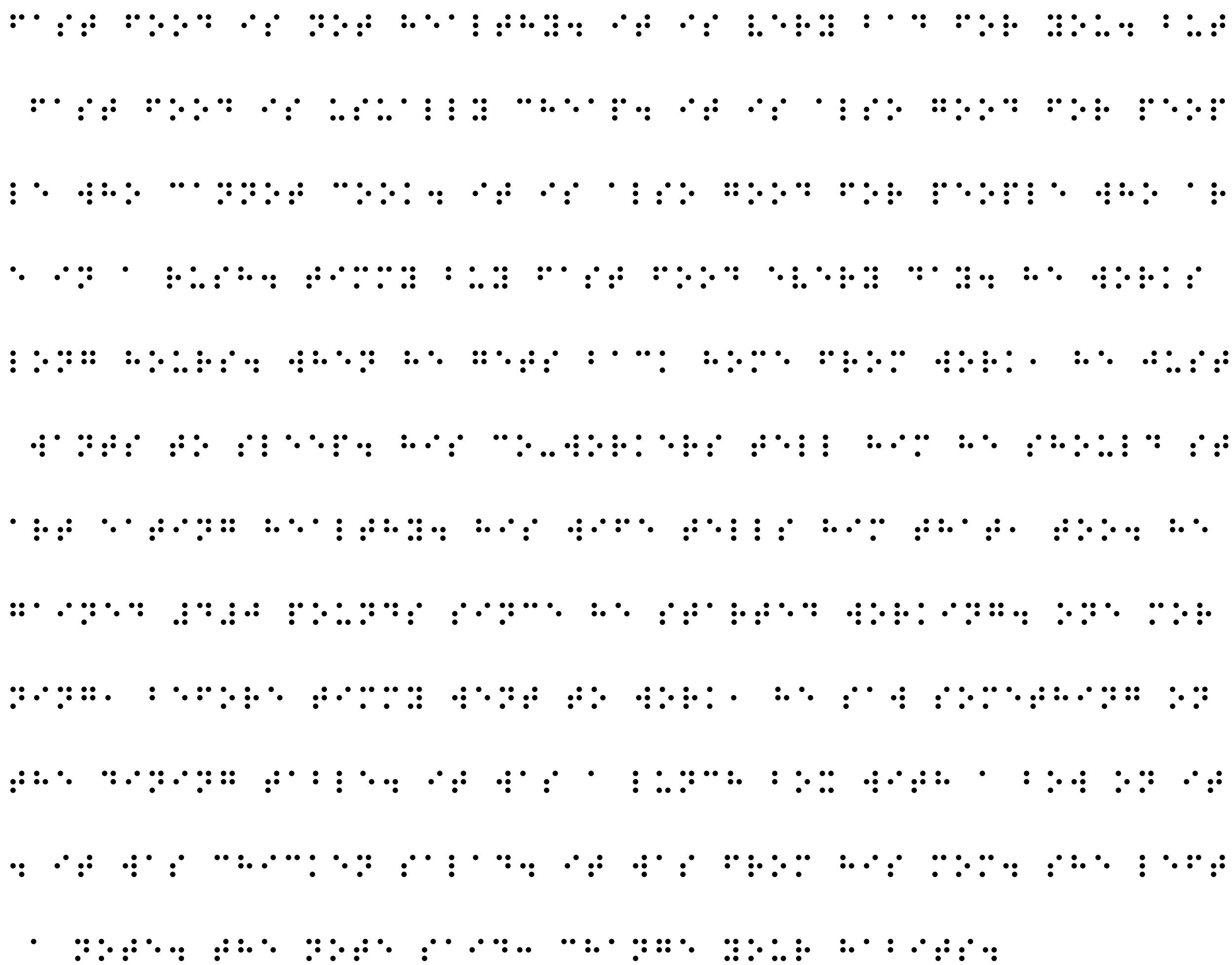
cum. prob	*t* .50	*t* .75	*t* .80	*t* .85	*t* .90	*t* .95	*t* .975	*t* .99	*t* .995	*t* .999	*t* .9995
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Appendix Q: The Used Reading Passage for Reading Speed Measurements



Source. Retrieved from: https://www.rong-chang.com/nnse2/nnse2/snse2004.htm

Appendix R: The Used Reading Passage in Braille Format



Appendix S: Glossary of the Eye Anatomy Terminology

Choroid: the middle layer of the eye containing blood vessels that nourish the other parts of the eye, especially the retina.

Ciliary Body: a ring of tissue between the iris and the choroid consisting of muscles and blood vessels that change the lens's shape and manufacture aqueous humor.

Conjunctiva: The delicate tissue that lines the inside of the eyelids and covers the front part of the eye except for the cornea.

Cornea: the clear curved structure that comprises the front of the eye, a refractive surface through which light enters.

Iris: colored circular membrane in front of the lens controls the size of the opening at its center (pupil), thereby regulating the amount of light entering the eye.

Lens: the transparent disc in the middle of the eye behind the pupil that brings light rays into focus on the retina.

Macula: the region of the retina that helps provide the best central vision. The fovea is at the center of the macula.

Optic Nerve: special nerve of sight beginning in the retina as the optic disk, which carries messages from the retina to the brain, resulting in visual images.

Pupil: the opening in the center of the iris that appears as a black dot through which light enters the eye.

Retina: innermost eye layer containing light-sensitive nerve cells and fibers connecting with the brain through the optic nerve and nourished by a network of blood vessels; receives the image and sends it to the brain.

Sclera: the white part of the eye; a tough covering that, along with the cornea, forms the external protective layer of the eye.

Vitreous Body: transparent colorless mass of soft gelatinous material filling the eye globe between the lens and the retina.

Source. National Center for Children's Vision and Eye Health (n. d)

ملخص

تهدف هذه الدراسة إلى اكتشاف تأثير استخدام التكنولوجيا المساعدة (AT) على معدل سرعة القراءة للغة الإنجليزية كلغة أجنبية (TEFL) للطلاب ضعاف البصر(VIS) . نشرت الدراسات السابقة أدلة محدودة في تدريس قراءة اللغة الإنجليزية لـ VISبسبب النقص البحث. في هذه الدراسة، شمل أخذ العينات العشوائية الطبقية ستة مشاركين من كل طبقة (عينة$_1$=6، عينة$_2$=6) كانوا مسجلين في مدرسة الرباح للأطفال المكفوفين وجامعة الواد للعام 2021/2020. اعتمد هذا البحث على منهج الاكتشاف المتسلسل للتطرق أسئلة البحث. من ناحية أظهر التحليل الموضوعي للمقابلات شبه المنظمة أن المستجوبين من مدرسة الرباح للأطفال المكفوفين يفتقرون إلى الموارد والمعرفة والتدريب على استخدام التكنولوجيا المساعدة. في المقابل، فان الطلاب ذوي القصور البصري من جامعة الواد استخدموا عديدا من أدوات التكنولوجيا المساعدة. لذلك فقد اختبروا إمكانية الوصول إلى المعلومات المطبوعة، وتقليل الاعتماد المفرط على الطلاب المبصرين، وموقفا إيجابيا اتجاه استخدام التكنولوجيا المساعدة في تعلم اللغة الإنجليزية. من ناحية أخرى فقد اظهر التحليل الإحصائي للاختبار القبلي والبعدي دلالة إحصائية. وفقا ذلك، كان متوسط سرعة قراءة للمشاركين في جامعة الواد باستخدام عارض برايل الكتروني (المتوسط=64.17، الانحراف المعياري=8.612) أكبر بشكل ملحوظ من متوسط سرعة القراءة باستخدام ورق برايل (المتوسط=56.83، الانحراف المعياري=8.495، قيمة ت (درجة حرية 5) =22.0021-، قيمة الاحتمالية p=0.000003603). في المقابل، كان متوسط سرعة القراءة للمشاركين من مدرسة الرباح في الاختبار البعدي (المتوسط=36.33، الانحراف المعياري=13.337) أقل بشكل ملحوظ من نتائج الاختبار القبلي (المتوسط=51.33، الانحراف المعياري=12.956، قيمة ت (درجة حرية 5) =5.78-، قيمة الاحتمالية p=0.00218). تبعا لذلك، كان كلا متوسط المجتمعين مختلفًا بشكل ملحوظ (مجتمع$_2$= المتوسط =36.33، الانحراف المعياري=13.337، مجتمع$_1$= المتوسط=64.17، الانحراف المعياري=8.612 قيمة ت (درجة حرية 10) =4.295-، قيمة الاحتمالية p= 0.0016 عند ألفا α=0.05). ونتيجة لذلك، تم اقتراح توصيات تربوية لمزيد من البحث.

الكلمات المفتاحية: التكنولوجيا المساعدة، سرعة القراءة، الطلاب ذوو القصور البصري، تدريس اللغة الإنجليزية كلغة أجنبية

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Résumé

Cette étude vise à explorer l'impact de l'utilisation de la technologie d'assistance (AT) sur taux de vitesse de lecture de l'anglais comme langue étrangère (TEFL) aux étudiants malvoyants (VIS). Des études antérieures ont publié des preuves limitées sur l'enseignement de la lecture en anglais pour le VIS en raison d'un manque de recherche. Dans cette étude, l'échantillonnage aléatoire stratifié comprenait six participants de chaque strate $(n_1 = 6; n_2 = 6)$. Ils étaient inscrits à la Robbah School for SVI et à l'Université EL-Oued pour 2020/2021. Cette recherche a adopté l'approche séquentielle exploratoire pour répondre aux questions de recherche. D'une part, l'analyse thématique des entretiens semi-structurés a révélé que les répondants de la Robbah School for SVI manquaient de ressources, de connaissances et de formation à l'utilisation des TA. En revanche, le VIS de l'Université EL-Oued a utilisé divers outils technologiques d'assistance. Par conséquent, ils ont fait l'expérience de l'accessibilité aux informations imprimées, d'une dépendance excessive minimisée vis-à-vis des étudiants voyants et d'une attitude positive à l'égard de l'utilisation de l'AT pour l'apprentissage de l'anglais. D'autre part, l'analyse statistique du pré-test et du post-test a montré une signification statistique. En conséquence, la vitesse de lecture moyenne des participants au VIS de l'Université El-Oued utilisant un afficheur braille électronique (M = 64,17, SD = 8,612) était significativement supérieure à la vitesse de lecture moyenne utilisant du papier braille (M = 56,83, SD = 8,495), t (5) =-22.0021, p=0.000003603. En revanche, la vitesse de lecture moyenne de Robbah School pour les participants SVI au post-test (M = 36,33, SD = 13,337) était significativement plus faible que les résultats du pré-test (M = 51,33, SD = 12,956), t (5)=-5,78, p=0,00218. Par la suite, la moyenne des deux populations moyennes était significativement différente ($\mu 2$ = M = 36,33, SD = 13,337; $\mu 1$ = M = 64,17, SD = 8,612), t (10) = -4,295, p = 0,0016 au α = 0,05). Par conséquent, des recommandations pédagogiques ont été proposées pour des recherches ultérieures.

***Mots-clés*:** Technologie d'assistance, Vitesse de Lecture, Etudiants ayant une Déficience Visuelle, Enseignement de L'anglais comme Langue Etrangère.