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Original Article

The Effect of Assistive Technology on Vocabulary Learning of Students with Visual Impairments

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Abstract

The present study sought to investigate the role of assistive technology (AT) in English vocabulary learning by students with visual impairment (VI) in an English as a foreign language (EFL) context. It also endeavored to elicit their attitudes towards AT through a semi-structured interview. To this end, 22 students with VI were divided into an experimental and a control group. Before the experiment, their initial vocabulary knowledge was measured through a pretest. Over five sessions, the experimental group was assigned to learn the target vocabulary items via a screen reader, i.e., non-visual desktop access (NVDA). In the absence of NVDA, the control group was exposed to the same vocabulary items by implicit instruction. Then, both groups received a posttest. The results of an independent samples *t*-test run on the data obtained from the post-test demonstrated that the experimental group built significantly larger vocabulary items than the control group. Responses given to a semi-structured interview revealed that learners prompted by AT acknowledged that the assistance afforded by NVDA, as a supplementary tool, facilitated learning the target vocabulary items. Based on the findings of the present study the incorporation of AT into the instructional materials of students with VI is recommended.

Keywords: Assistive Technology, NVDA, Screen Reader, Students with VI, Vocabulary Learning

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1. Introduction

The bulk of English as a foreign language (EFL) materials available on the market have almost little to cater to the needs of learners with visual impairment (VI) (e.g., Klingenberg et al., 2019; Özer & Cabaroğlu, 2018). As Klingenberg et al.'s (2019) review of the extant literature on students with VI revealed "there is [still] lack of scientific evidence to establish research-based practice related to e-learning programs for students with VI" (p. 14). Although learners with VI are now increasingly mainstreamed or included in colleges, universities, and technical schools, the level of competence they finally develop in English leaves them depressed and frustrated. Compared with their sighted peers, students with VI are usually reported to obtain poor scores in general education and language-related skills including English vocabulary knowledge (Jitendra et al., 2004). This is so even though hope was cherished to assist such students to be on par with their sighted peers before the turn of the century (Abner & Lahm, 2002). With the release of equal rights for sighted and visually-impaired people (United Nations, 2006), in which learning English as a lingua franca has been underlined as essential for students with VI, many stakeholders have taken the initiative in developing "vision substitution skills" to facilitate learning English for this group of students.

One of the most prominent vision substitution tools ever invented for students with VI is Braille which has already proven virtually indispensable in literacy, spelling, and reading fluency (Argyropoulos et al., 2020). If proficient enough in Braille, students with VI can also turn technology to their advantage as an additional vision substitution tool and stretch their learning to some significant degree.

To empower learners with disabilities in science, technology, engineering, and mathematics (STEM), as well as language learning, researchers have recently embarked on digital technology more than ever. One of the technological tools widely used with learners with disabilities in general and students with VI, in particular, is assistive technology (AT) which is defined as "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (The Assistive Technology Act, 2004, p. 1710). Framed in educational contexts, AT refers to any digital device that assists learners with disabilities to access learning materials and perform learning tasks with ease. It encompasses low-tech and high-tech devices. Included in the former are devices that are

user-friendly and cost-effective, requiring no special systematic training such as Braille handwriting, magnifiers, and walking/assistive canes (Wachiuri, 2015). Computers and screen readers (i.e., reading the text out loud in computer-synthesized voice), which entail intensive training (Wong & Cohen, 2011) are packed in the latter. High-tech devices include hardware options including alternative keyboards, and screen magnifiers, as well as software options such as voice recognition, onscreen keyboards, and optical character recognition (Hussin, 2013).

AT can hardly be taken as a replacement for Braille in so far as audio input lacks the optimum capacity to cultivate literacy. As such, AT can only serve as an additional and supplementary tool to enhance the learning of students with VI provided that they have already developed enough proficiency in Braille. Previous studies have vividly shown that AT is likely to contribute to improving students' word recognition and reading comprehension abilities, developing reading comprehension strategies (Higgins & Raskind, 2004), and reinforcing reading, proofreading, and writing skills (e.g., Raskind & Higgins, 1998). AT has also proven to significantly assist students with VI to perform more accurately and gain knowledge, confidence, and independence in performing tasks. Nevertheless, only a few studies (e.g., Özer & Cabaroğlu, 2018; Stein et al., 2011) have explored the role of AT in learning English vocabulary by students with VI in an EFL setting.

Although vocabulary is viewed as the building block of any language and can accelerate comprehension, students with VI appear to experience slow progress in vocabulary learning compared with their sighted peers. Their poor vocabulary repertory can be correlated with their limited exposure to input whereas their sighted peers are privileged enough to have access to a range of materials. Admittedly, students with VI may feel frustrated when they fashion an interaction with sighted learners in an inclusive classroom. By the same token, if required to perform any reading or writing tasks, they stand less chance of escaping the embarrassment. Worst still, students with VI lag well behind in acquiring digital literacy. With the assistance of AT (e.g., digital talking textbooks), however, students with VI may become empowered to listen to digital materials which can in turn lead to their second language development.

2. Literature Review

2.1. AT and Language Teaching

There exist different examples of AT that can assist students with VI including screen readers (e.g., Job Access with Speech [JAWS], Kurzweil, NVDA (Non-visual Desktop Access)), talking calculators, audiobooks, Braille note-takers, Braille embossers, screen magnifiers, tactile maps, magnifying glasses, and scanners with optical character recognition. Provided with such devices, students with VI are afforded opportunities to improve their learning. Screen readers, for instance, enable students with VI to have access to new pieces of information through the Internet and participate in online discussions (e.g., Lee & Templeton, 2008).

2.2. Barriers to AT

A number of studies (e.g., Copley & Ziviani, 2004; Kapperman et al., 2002) have addressed the challenges which learners with disabilities encounter when using AT devices. Findings have asserted that one-third of AT devices are underused due to several factors such as the high costs of the equipment, the lack of knowledge on the part of the teachers (e.g., Abner & Lahm, 2002; Alper & Raharinirina, 2006), and the lack of technical support and eligibility issues for possessing devices (Zhang, 2000). Alper and Raharinirina (2006) found that students with VI do not use AT at home or school. Hussin (2013) also reported that Malaysian students find AT difficult and challenging to use.

Copley and Ziviani (2004) identified six main barriers which stymie the effective use of AT devices among students with multiple disabilities, namely: (a) lack of appropriate staff training and support, (b) negative staff attitudes, (c) inadequate assessment and planning processes, (d) insufficient funding, (e) difficulties procuring and managing equipment, and (f) time constraints. In a study conducted on elementary and high school students with VI in Illinois, Kapperman et al. (2002) concluded that between 59% and 71% of the learners were deprived of the opportunities to benefit from AT devices. Insufficient provision of AT devices, insufficient time to provide training for students, insufficient funds to purchase the AT devices, and the lack of appropriate teacher training were shortlisted as the main barriers. In the process of obviating such barriers, training both teachers and learners can serve as a starting point.

2.3. NVDA

To Michael Curran and James Teh's (two fully non-visual men) credit, NVDA was developed in April 2006. It is a free screen reader that allows students with VI to take advantage of technology to improve their learning, have access to more information, and benefit from social networking, online shopping, banking, news, and even language learning. To date, NVDA has been downloaded more than 70,000 times, translated into 80 languages, and utilized in more than 12 countries around the world. Its open-source feature allows translators and material developers to contribute to its expansion and improvement. Moving the cursor on every entry, students with VI can hear whatever is displayed on the screen.

NVDA can easily surf the Internet through browsers such as *Mozilla Firefox, Google Chrome,* and *Internet Explorer*. It also works with *Microsoft Word, Microsoft PowerPoint*, and *Microsoft Excel*. NVDA can convert on-screen materials into audio (in computer-synthesized speech) or Braille (through a refreshable Braille display device) in which opportunities for improving the spelling of students with VI can be opened up. The studies which have specifically compared the impact of Braille vs. AT devices on the spelling of students with VI (e.g., Papadopoulos et al., 2009) have collectively reported that Braille is more effective. While learning a new vocabulary item, students with VI find learning spelling more challenging than learning its meaning (Stein et al., 2011). This finding can be explained by the fact that most AT devices present learning materials for students with VI just in the audio format. NVDA, however, can catch the attention of students with VI to misspelling too. With its *Document Formatting Options* enabled, NVDA buzzes for the students with VI to take notice of any misspelled word.

Even though the role of smartphone usage (Abraham, et al., 2022) and Facebook usage (Gkatzola & Papadopoulos, 2022, 2023) has been examined widely, to date, only a few studies (e.g., Özer, & Cabaroğlu, 2018) have employed AT to teach English vocabulary to students with VI. To examine the capacity of NVDA to increase vocabulary learning of students with VI, a plethora of future studies are required to focus on the role of variant features of the device regarding different dimensions of vocabulary learning.

2.4. Empirical Studies

Although many studies (e.g., Kapperman et al., 2002) have demonstrated the positive role which AT appears to play in the learning experience of students with VI, research so far has revealed that there is still a great deal of reluctance on the part of teachers to infuse AT into the classrooms of students with VI because of the lack of knowledge, facility, and time (e.g., Abner & Lahm, 2002). Hussin (2013) set out a qualitative study in Malaysia to assess the effect of digital talking textbooks (DTTs) (Introduced by the Malaysian Ministry of Education in 2009) on facilitating the learning of students with VI. The study also surveyed the factors that make students with VI adopt or reject DTTs. For this purpose, 12 learners were interviewed in-depth. The data collection procedures include: (a) asking each student to answer the demographic information and sign the consent form for audio-recording the interview (b) eliciting the participants' experience with DTTs during the individual semi-structured interview (c) running the interview (d) recording each interview using a digital audio-recorder. Each student listened, made adjustments, and confirmed that the transcription illustrated the experience that he/she wanted to convey during the interview. The interviews were conducted and transcribed literally in Malay. Then the transcripts were translated into English with the assistance of an English teacher.

Results demonstrated that participants perceived DTTs as responsive to their needs. However, some students complained about the technical difficulties associated with using DTTs. Generally, when they felt that DTTs did not apply to some devices and subject matters such as science and languages, they turned their use down. Students shared different experiences in using DTTs and acknowledged the characteristics of DTTs that maintained their enthusiasm about DTTs.

A review of the literature reveals that only a few studies have addressed vocabulary learning by students with VI (e.g., Özer & Cabaroğlu, 2018). In a survey study, Stein et al. (2011) attempted to elicit the learners' attitudes towards a computer-based "auditory vocabulary and spelling trainer" in an EFL context. To this end, a questionnaire was given to 15 students with VI, and an online survey was conducted on 88 visually impaired adults to examine the role of the AT device in improving learners' vocabulary and spelling. Results confirmed their positive attitudes towards the efficacy of the device in the learning of students with VI.

Recently, Özer and Cabaroğlu (2018) conducted a qualitative case study to gain insights into the way vocabulary is taught to students with VI and the challenges their

teachers face in the process of offering the materials. The data was collected through a semi-structured interview with two EFL teachers at a school for students with VI. Results indicated that both teachers resorted to AT auditory devices when teaching vocabulary to students with VI. They singled out orthography, lack of enough materials appropriate for students with VI on the market, time limitations, and high dependence of students with VI on others in studying among the main concerns of both teachers.

With few exceptions that have followed experimental designs (e.g., Retorta & Cristovão, 2017), studies on the effect of AT on language teaching and learning have primarily adopted survey designs (e.g., Hussin, 2013; Özer & Cabaroğlu, 2018). The present study intends to shed more light on the effect of AT on the vocabulary development of students with VI by employing a quasi-experimental design with NVDA and implicit vocabulary teaching serving as two levels of the independent variable and vocabulary learning as the dependent one. It further elicited the attitudes of learners toward NVDA. The objective of the present study is to explore the influence of non-visual desktop access (NVDA), which is a type of AT, on vocabulary learning of Iranian students with VI addressing the following research questions.

1. Would NVDA enhance the vocabulary learning of beginning-level students with VI**?**
2. What are the attitudes of students with VI towards using NVDA to improve their vocabulary repertoire?

3. Methodology

3.1. Design and Context of the Study

The present study followed a quasi-experimental design in a high school for students with VI in Tehran, Iran.

3.2. Participants

The participants of this study were 22 male students with VI. They were beginning-level learners of English aged 17–22. Of the 22 students with VI, the first language (L1) of 16 learners was Persian, while the L1 of the remaining learners was Azari-Turkish (n = 4), Kurdish (n = 1), and Lori (n = 1). They had no other physical or mental disability. Students with VI in Iran receive the same textbooks assigned for sighted learners by the Ministry of

Education but in Braille. In primary school, they learn alphabetic Braille for six years, and in high school, they receive contracted Braille, when they are taught English, for six additional years (Mobaraki et al., 2017). All the teaching and assessment materials are delivered in Braille in which all of them are proficient.

The participants sampled conveniently were randomly divided into an experimental group and a control group. There were two low-vision learners in the experimental group and three in the control group. However, the low-vision learners of the experimental group, like their blind peers, relied on utilizing NVDA without seeing the screen.

Before the study, all participants were interviewed to elicit 19 pieces of background information including their age, L1, familiarity and experience with NVDA, etc. Their responses indicated that approximately half of the participants had already attended English language institutes to improve their English, but the remaining half had only received school instruction. The majority of participants had a good command of NVDA with only four learners lagging in using NVDA who were included in the control group. Eight learners expressed that they were not using NVDA frequently. Of the remaining individuals, only three learners had access to NVDA only at school while the other learners had used it at home. Using NVDA by learners ranged from 30 min to six hr per day. The responses of the learners to the first section of the background interview are presented in Table 1. The results of the second section are presented in Table 4.

Table 1.

Results of the Background Interview

Groups	Degree of Visuality	Age	L1	The place of Learning English	Familiarity with NVDA	Daily experience with NVDA? Where?	Duration of daily use of NVDA
Experimental (n = 11)	Non-visual	17	Persian	Institute	Very good	Yes/home	6 hours
		17	Persian	School & 1 term Institute	Good	Yes/school	30 min
		19	Turkish	School	Not bad	No	_____
		20	Turkish	School & Institute	Not bad	No	_____
		18	Turkish	Institute	Very good	Yes/home	30 min
		19	Lori	School	Very good	Yes/home	5 hours
		20	Persian	School	Not bad	Yes/school	30 min
		18	Persian	School	Good	Yes/home	1 hour
		18	Persian	School	Poor	No	30 min
	low-vision	20	Persian	School	Not bad	Yes/home	30 min
		18	Persian	School & Institute	Good	Yes/home	1 hour
Control (n = 11)	Low-vision	18	Persian	School & Institute	Good	Yes/home	30 min
		18	Persian	School	Yes	Yes/home	1 hour
		19	Persian	School	No	No	_____
		19	Persian	Self-trained	A little	No	_____
		22	Persian	School	Good	No	_____
		18	Persian	School	No	No	_____
		18	Persian	Institute	Good	Yes/school	30 min
	Non-visual	17	Kurdish	Institute	Very good	Yes/home	2 hours
		18	Persian	Institute	Very good	Yes/home	30 min
		18	Persian	School	Not bad	No	_____
		18	Turkish	Institute	Not bad	Yes/home	30 min

3.3. Materials

A total of 58 highly frequent target words including nouns (n = 26), adjectives (n = 5), and verbs (n = 27) were selected to be taught to the students with VI who voluntarily agreed to participate in the current study.

3.4. Instrument(s)

To conduct the present study, the following instruments were used. The materials were piloted by a TEFL expert and a teacher of students with VI to compare their reliability indices.

3.4.1. Background Interview

A 19-item background interview was run in two sections. The first section (n = 7) elicited some background information on learners' age, first language, years of exposure to English, familiarity with NVDA, etc. The second section (n = 12) addressed the degree of their expertise in utilizing NVDA. The questions were rendered to learners individually in Persian and their responses were audio-recorded for further analysis.

3.4.2. Attitude Interview

To elicit the attitudes of the individuals in the experimental group toward the treatment, an attitude interview was conducted in Persian after the posttest. The semi-structured interview was comprised of two sections including 24 five-point Likert scale items and one open-ended question. The first section, including 8 items, asked learners' perception of AT and their previous experience with AT in their personal life. The second section, consisting of 16 items, elicited learners' attitudes toward the use of NVDA in learning English, their preference for an English teacher with VI, etc. It also included an open-ended question to elicit learners' attitudes toward the advantages and disadvantages of AT. The experimental group responded to the items of the two sections; however, the control group answered only the first section of the interview. Like the background interview, the questions were asked in Persian and the responses were audio-recorded.

3.4.3. NVDA

NVDA software, downloaded from *https://nvda.en.softonic.com/download*, was used in the present study since it is a free and user-friendly AT with which many students with VI are familiar. It was installed on a laptop. As participants reported in the background interview, they were already familiar with NVDA keyboard commands as a result of trial and error. They had practiced learning each key's place on the keyboard with the help of a sighted person. Owing to enough practice they had, the students with VI in the present study could work with the keyboards more like a sighted person. To get started with NVDA, participants were required to choose *Start, All Programs, and NVDA*. Upon hearing a tone, they understood that NVDA was running in the background. To hear what was then on the screen, i.e., the reading task, they started moving the mouse around. NVDA read aloud what was under the cursor as they moved the mouse.

While NVDA was running, they could use all of the seven standard Windows keyboard shortcuts as well. To pause NVDA, they pressed the *Control key* on the keyboard. Pressing the *Control key* again resumed NVDA. Most NVDA commands require learners to use the *Insert key* on their keyboard. To hear the title of the current window, they pressed *Insert T*. To hear the contents of the available window, they also pressed *Insert B.* To quit NVDA, they pressed *Insert Q*. To start NVDA using the keyboard, they pressed *Control, Alt*, and *N*. Figure 1 illustrates a screenshot of NVDA keyboard commands.

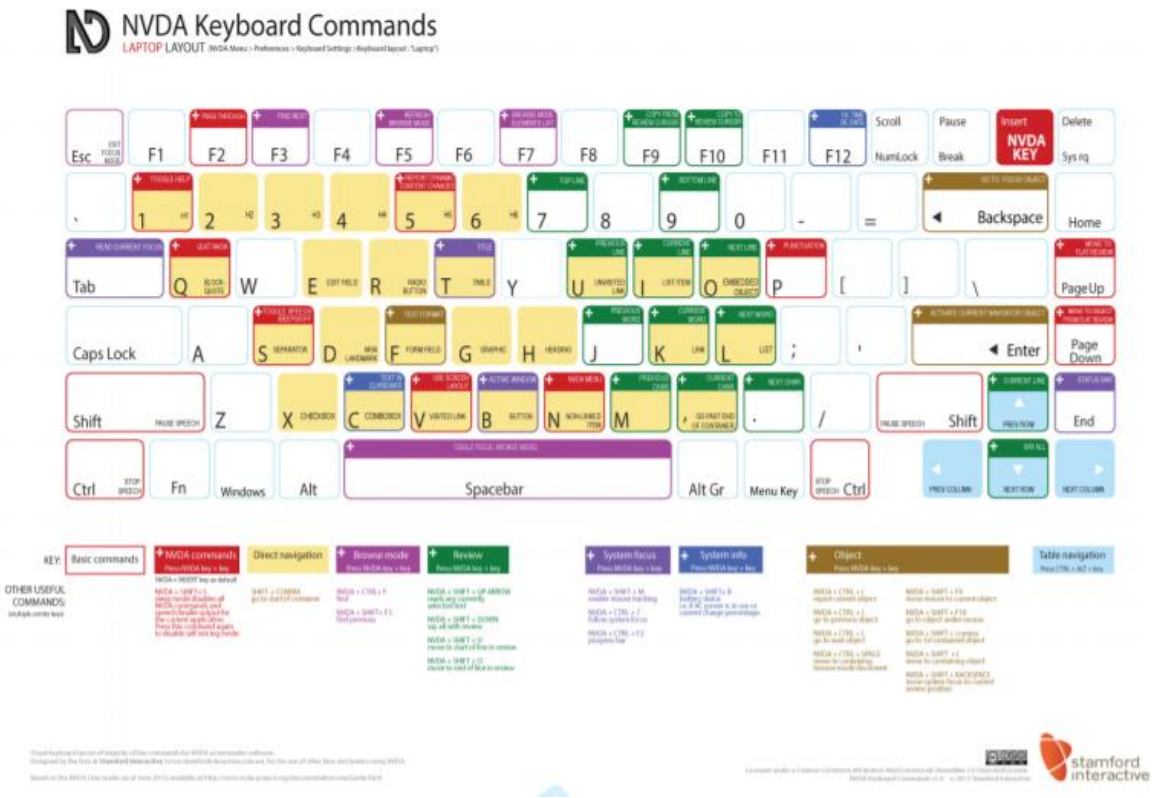

Figure 1. The screenshot of NVDA.

3.4.4. Pretest and Posttest

A 30-item multiple choice researcher-made pretest was used to measure their prior knowledge of the target vocabulary items. The pretest included 30 words out of the pool of 58 target vocabulary items. The reliability index computed for the pretest was .74. Another 30-item researcher-made posttest, parallel to the pretest, with a reliability index of .79 was used.

3.4.5. Reading Tasks

Over 5 sessions, students with VI received 15 short stories (three tasks for each session embedded with 10–12 new words), prepared by the authors, with the target vocabulary items embedded. Learners were asked to listen to those stories with 3–4 new vocabulary items iterated in each task. Iteration, "the opportunity to revisit the same territory again and again is different from repetition … and is important for language learning" (Larsen-Freeman, 2013, p. 121). For example, the word headache was iterated in input in the following way:

*Lois has a **headache**. The **headache** started one hour ago. She never gets **headaches**. She never gets sick.*

After listening to those stories using NVDA, they were given a 10-item fill-in-the-blank activity in which each new vocabulary item was missing once. Each word was iterated 3 times in each story and one more time in the fill-in-the-blank activity which was supposed to be provided by the students with VI. The reading tasks were piloted by two EFL experts before the study to remove any ambiguity and make it as comprehensible as possible.

3.5. Data Collection Procedure

A 5-session extracurricular class was held for students with VI to teach 58 target vocabulary items selected randomly from *English Vocabulary in Use* for elementary-level learners' books. The classes were held for students with VI in Tehran, Iran. In the first session, all learners were given a consent form and then were interviewed to elicit some pieces of background information. Learners were then given the pretest. Although the participants were proficient enough in using Braille, due to some practicality concerns and expensive Braille printouts, the authors gave the pretest in audio form. The participants were asked to listen to the pretest and utter the correct alternatives. Their responses were audio-recorded for further analysis. The learners' correct answer to each of the items in the pretest was given one score and counted. According to the results of the pretest, 22 participants were randomly divided into an experimental and a control group (11 in each).

Although the results of the background interview revealed that the majority of learners were good at NVDA, the experimental group was given a 15-minute instruction, in session two, to ensure that all participants had an equal command of using NVDA to listen to the reading tasks and using the online dictionary accessible with NVDA. In each session, the experimental group was exposed to NVDA and was required to listen to the three short stories designed to iterate the target vocabulary items. They were required to listen to those tasks as many times as they liked. In each task, they were exposed to 3–4 new vocabulary items. They were required to guess the meaning of the new vocabulary items relying on the context; if they failed to infer the meaning of the new vocabulary items, they were asked to look up the new words in the online dictionary provided by NVDA. The teacher (the second author) was also open to their questions if they asked for the meaning of any word or

sentence. As soon as they were done with reading each story, the participants were given a 10-item fill-in-the-blank exercise, read by NVDA, to answer it orally. Their responses were audio-recorded. Figure 2 represents how students with VI utilized NVDA independently in the classroom. The participants and the school principal as well agreed to the appearance of their photo in the present article.

Figure 2. The experimental group using NVDA.

The control group received the reading tasks but instead of NVDA, the teacher read the texts aloud twice. Individuals in the control group were also encouraged to guess the meaning of the new vocabulary items; however, the teacher provided them with the meaning of any word or sentence at their request. They were then required to do the fill-in-the-blank activity. At the end of the study, the posttest was administered. Immediately after the posttest, learners were interviewed to elicit their attitudes toward the treatment.

3.6. Data Analysis Procedure

For the pretest and posttest items, each correct answer was given one score, while the wrong answers were assigned no score. The maximum score for the pretest and posttest was 30. To see if there was any statistically significant difference between the means standing for the performances of the two independent samples on the pretest and the posttest after being treated differently in the experiment, the scores obtained from these two samples were submitted to two *t*-tests using SPSS. The basic assumptions made for running *the t*-test were met.

4. Results

4.1. Quantitative Data Analysis

To answer the first research question, i.e**.,** would NVDA enhance the vocabulary learning of beginning-level students with VI?, two separate independent samples *t*-tests were run for the results of the pretest and post-test. Table 2 represents the descriptive statistics for the two groups' performance on the pretest. A look into the mean scores of the two groups indicates that they performed similarly on the pretest (the experimental group: $M = 4.82$, $SD = 2.56$, the control group: $M = 3.36$, $SD = 2.25$).

Table 2.

Descriptive Statistics for the Two Groups' Performance on the Pretest

Groups	*N*	*M*	*SD*	*SEM*
Experimental	11	4.82	2.52	.761
Control	11	3.36	2.25	.678

An independent samples *t*-test run on the data obtained from the pretest showed that there was no statistically significant difference between the two groups' knowledge of vocabulary, $t(20) = 1.42$, $p = 0.16$. The second independent *t*-test was run on the data obtained from the post-test. The descriptive statistics for the post-test (Table 3) represent that the mean scores of the experimental group ($M = 10.45$, $SD = 3.69$) were much larger than that of the control group ($M = 7$, $SD = 4.07$).

Table 3.

Descriptive Statistics for the Two Groups' Scores on the Posttest

Groups	*N*	*M*	*SD*	*SEM*
Experimental	11	10.45	3.698	1.115
Control	11	7.00	4.074	1.228

Results of the independent samples *t*-test for the posttest showed that there was a statistically significant difference between the two groups' performance on the posttest, $t(20) = 2.08$, $p = 0.05$, implying that the experimental group outperformed the control group in learning the target vocabulary items significantly.

4.2. Results of the Interview

To answer the second research question, i.e., what are the attitudes of students with VI towards using NVDA to improve their vocabulary repertoire?, learners' responses to the second section of the background interview were probed into whose quantifications are presented in Table 4.

Table 4.

Responses of Participating Students to the Second Section of the Background Interview

Questions	Yes	No	Makes no difference
1. Have you already been familiar with NVDA?	16 (73%)	6 (27%)	
2. Have you ever used NVDA at home?	6 (27%)	16 (72%)	
3. How long do you use NVDA daily?	1–6 hours		
4. Do you use NVDA skillfully?	4 (18%)	18 (81%)	
5. How long did it take to learn NVDA?	1 day–3 month		
6. Have you used NVDA to learn English?	5 (23%)	17 (77%)	
7. Have you used NVDA to learn other courses?	5 (23%)	17 (77%)	
8. Is your English class specific for students with VI?	0	22 (100%)	
9. Have you had teachers with VI?	22 (100%)	0	
10. Do you prefer visual teachers over non-visual ones?	7 (31%)	7 (31%)	8 (36%)
11. Do you like inclusive classrooms?	12 (54%)	8 (36%)	2 (9%)
12. Do you prefer NVDA over Braille to learn English?	14 (63%)	8 (36%)	

Results demonstrated that 73% of learners were already familiar with NVDA and 27% of them expressed that they had worked with NVDA at home. Only 18% (n = 4) of the students with VI reported using NVDA skillfully before they participated in the current study. The participants asserted that it took one day up to three months to learn how to use NVDA; they used NVDA 1–6 hr per day. However, 23% had already used NVDA to learn

English. A total of 77% had not utilized NVDA for other courses while 23% had. All learners (100%) expressed that there was no specific class for the students with VI at institutes and all stated that they had teachers with VI at school. While 31% of the learners preferred sighted teachers, 31% of them preferred teachers with VI, and for 36% of them, it made no difference. The next item asked about their inclination towards inclusive classrooms. Fifty-four percent of the learners agreed, 36% disagreed, and 9% chose to go for no difference. Those who disagreed argued that sighted learners cannot understand them or they might make fun of them. Interestingly, 63% of the respondents preferred NVDA over Braille in learning English.

The frequency of responses to the attitude interview was calculated manually too. Responses of both groups to the first section, including 8 items about learners' opinions about using AT in personal and educational life, are presented in Table 5.

Table 5.

Responses of All Participating Students to the First Section of the Attitude Interview

Section 1: AT devices	Strongly agree	Agree	No idea	Disagree	Strongly disagree
1. Having access to AT in English language classrooms is very important for students with VI.	14 (63%)	5 (22%)	3 (13%)	0	0
2. Using AT devices such as NVDA in the class is very time-consuming.	6 (27%)	5 (22%)	7 (31%)	3 (13%)	0
3. Using AT devices can help me learn English independently.	10 (45%)	5 (22%)	3 (13%)	3 (13%)	1 (5%)
4. The teachers' lack of experience in using AT devices in the class can hinder the success of students with VI.	5 (22%)	4 (18%)	3 (13%)	5 (22%)	5 (22%)
5. I am not interested in using AT devices since most of the time they don't work properly.	1 (5%)	1 (5%)	7 (31%)	10 (45%)	3 (13%)
6. Using AT devices, I usually come across failure and disappointment.	2 (10%)	2 (10%)	5 (22%)	7 (31%)	6 (27%)
7. Students with VI are not interested in using AT devices.	1 (5%)	1 (5%)	6 (27%)	3 (13%)	11 (50%)
8. The lack of knowledge of students with VI on AT devices is one of the reasons of their dissatisfaction.	12 (54%)	1 (5%)	7 (31%)	2 (10%)	0

The results (Table 5) indicated that for 85% of participants, access to AT devices in the classroom was very important. However, 49% of learners found AT devices like NVDA time-consuming. Around 45% of learners stated that AT devices helped them develop a sense of independence in educational life. But 40% of learners considered the lack of teachers' experience in incorporating AT into the classrooms as one of the most determining reasons for their reluctance to introduce AT devices to students with VI. About 10% of learners were against infusing AT because they held the view that most of the time it doesn't work properly. However, 20% declared that when AT devices are plagued with glitches, they become desperate. The insufficient experience was pointed out as the primary reason by 59% of the respondents for their lack of interest in using AT devices.

Table 6.

Responses of the Experimental Group to the Second Section of the Attitude Interview

Section 2: NVDA	Strongly Agree	Agree	No Idea	Disagree	Strongly Disagree
1. I usually use NVDA for doing my homework.	4 (36%)	0	0	4 (36%)	3 (27%)
2. Before this extra-curricular class, I had used NVDA skillfully for learning English.	0	0	0	10 (90%)	1 (10%)
3. The speed of speech of NVDA is good for comprehension.	3 (27%)	7 (63%)	1 (10%)	0	0
5. Learning vocabularies via NVDA is long-lasting.	5 (45%)	1 (10%)	4 (36%)	1 (10%)	0
6. When new vocabularies are repeated in different contexts, learning can be effective.	6 (54%)	4 (36%)	0	1 (10%)	0
7. The knowledge of vocabulary is very important in learning English.	5 (45%)	5 (45%)	1 (10%)	0	0
8. Using NVDA to learn English is effective.	7 (63%)	2 (18%)	2 (18%)	0	0
9. English teachers should emphasize using NVDA in the class.	8 (72%)	3 (27%)	0	0	0
10. I will use NVDA for learning vocabulary from now on.	4 (36%)	4 (36%)	1 (10%)	1 (10%)	1 (10%)

11. I will recommend using NVDA for learning vocabulary for my friends.	4 (36%)	4 (36%)	1 (10%)	1 (10%)	1 (10%)
12. I think using only NVDA for learning vocabulary is not enough.	3 (27%)	4 (36%)	3 (27%)	1 (10%)	0
13. NVDA improved my pronunciation.	5 (45%)	1 (10%)	5 (45%)	0	0
14. Learning spelling via NVDA is very easy.	5 (45%)	1 (10%)	5 (45%)	0	0
15. The teachers' familiarity and good attitude towards NVDA can motivate students with VI a lot.	10 (90%)	1 (10%)	0	0	0
16. Since I had already used NVDA for other purposes, I found using it to learn vocabulary helpful.	2 (18%)	1 (10%)	7 (63%)	1 (10%)	0

The second section of the questionnaire (Table 6) elicited only the experimental learners' attitudes toward NVDA. Results showed that the experimental group unanimously had a positive perception of using NVDA for learning new vocabulary items. About 63% of them had no previous experience using NVDA for doing their homework. All of the learners interviewed (100%) reported that they had never utilized NVDA for learning English. Their responses to this item reflect the novelty (Jeno et al., 2019) of their experience in using NVDA for learning English. Ninety percent of the learners believed that the speed of speech delivered by NVDA was appropriate enough for them to comprehend the texts easily. Around 55% of learners stated that learning vocabulary with NVDA can lead to long-lasting learning. Almost 90% of learners believed that iteration was a useful way to learn vocabulary items. Also, 90% of the students with VI stated that vocabulary is the main component of English.

Around 81% of the learners considered NVDA as an effective tool for learning English. Interestingly, 100% of the learners expected teachers to introduce NVDA to students with VI in the classrooms. About 72% of them expressed that they would use NVDA for learning vocabulary and recommend it to their friends. Nearly 63% of the learners stated that using NVDA cannot be the only appropriate tool for learning vocabulary items. Such an attitude substantiates the importance of considering NVDA as a supplementary tool for learning English in general and vocabulary in particular. Also, 55% of the students with

VI expressed that NVDA improved their pronunciation and spelling while 45% adopted the *no idea* stance. As expected, 100% of learners opted for the important role the teacher can play in helping learners utilize NVDA for language learning purposes and in changing their attitude towards AT devices. Surprisingly, only 28% of the learners believed that their prior experience and familiarity with NVDA to learn other subject matters helped them learn English vocabulary items easily while 63% had no idea and only 10% had a countering point of view.

The last question of the interview elicited the experimental learners' opinions on the advantages and disadvantages of AT. The respondents enlisted some advantages of AT. Some instances of their responses are presented below:

"It can help learners have greater control over their learning."
"It helps learners participate and interact more in activities at home, school, and job."
"It provides opportunities to interact with people who do not have disabilities."

However, learners pointed out some disadvantages to be associated with AT including disturbing the privacy of students with VI, lack of human support, physical regression, and heavy reliance on AT. They also believed that reliance on AT can deprive them of human support which may fade away daily, as people with disability try to replace human support with AT. Even though AT can solve their physical problems, their emotional health can only be guaranteed by interaction with human beings. Therefore, students with VI mainly referred to the following disadvantages:

Lack of privacy: With AT devices the privacy of the individuals is mostly violated. It allows the helper or the nurse to have access to their personal information.

Regression: Learners with disabilities might rely entirely on AT devices and not attempt to overcome their disabilities which might be aggravated over time.

Complexity: Some AT devices are complex and user-unfriendly. These features might lead to their frustration.

5. Discussion

The current study investigated the role of NVDA, as an instance of AT, in learning vocabulary by students with VI. It also attempted to elicit their attitude towards NVDA in learning English vocabulary. Results indicated that the group assisted with NVDA

outperformed the control group in learning the target vocabulary items significantly. Findings are in line with some previous studies that have reported the positive effect of AT on learning English in general (e.g., Higgins & Raskind, 2004) and vocabulary development in particular (e.g., Özer & Cabaroğlu, 2018). The outperformance of the experimental group in the present study might be attributed to the potentiality of NVDA in fostering self-paced learning by offering opportunities for monitoring individual speed, decreasing cognitive overload (Chen, 2012), and providing the possibility of listening to some parts more than once, when the need arises (Zhang et al., 2006) so that students with VI can promote their learning.

Stated differently, being exposed to self-paced learning, the students with VI of the present study might have controlled their learning at their own pace. Results of the current study lend support to some previous studies (e.g., Bautista, 2015; Palaigeorgiou & Papadopoulou, 2019) which have concluded that self-paced learning can lead to the success of the learners. In addition to self-paced learning, AT increases students' autonomy and independence, boosts their self-esteem (Goldfus & Gotesman, 2010), and accelerates their learning.

Furthermore, as learners reported in the interview, using NVDA for learning English was a novel experience for the students with VI of the present study. Such a novel experience supported by the novelty effect (e.g., Chandra & Lloyd, 2008; Jeno et al., 2019) might have generated the motivation of students with VI to keep track of NVDA more enthusiastically to learn the vocabulary items well.

Results of the interview demonstrated that learners had positive attitudes towards AT. Findings are in alignment with previous studies (e.g., Hussin, 2013; Özer & Cabaroğlu, 2018; Susanto & Nanda, 2018) concerning the positive attitudes of students with VI towards AT. Most of the learners stated that they had not considered NVDA as a useful device for vocabulary learning before this study. Nearly all of them expressed that their teachers had not paid any attention earlier to AT in the language learning classrooms. This finding is supported by previous studies (e.g., Abner & Lahm, 2002; Alper & Raharinirina, 2006) which pointed out the reluctance of the teachers in infusing AT into classrooms. Most learners were interested in using NVDA and approximately all learners judged iteration in learning vocabulary as essential and emphasized that it should be included in school English lessons too.

Although students with VI of the present study appreciated the supportive role of NVDA in learning vocabulary, they explicitly expressed that NVDA met with little success as the only source of language learning. Findings corroborate previous studies (e.g., Argyropoulos et al., 2020) which have maintained that AT can be utilized as a supplementary and additional tool along with other vision substitution tools, not least Braille which makes a great contribution to literacy and language learning and has demonstrated that substituting AT with Braille can delay literacy cultivation.

6. Conclusion

The present study foregrounded the role of AT in language learning of students with VI which has been put on the back in Iranian classrooms and textbooks. The results of the current study demonstrated that NVDA functioned as an effective AT device in helping students with VI learn the target vocabulary items. Moreover, the results of the interview showed that learners developed positive attitudes towards the role of AT, specifically NVDA, in learning English vocabulary. The students with VI of the present study stated that English teachers don't pay attention to the importance of technology as a supplementary tool to teach English to them in the classroom. This is most of the time due to the lack of technology training on the part of the teachers. Tallvid (2016) argued that some teachers avoid technology in class, because of several reasons such as the lack of digital literacy, the lack of facilities, and the lack of time.

These findings are an initial attempt to explore the role of AT, particularly NVDA, in improving the Iranian language learning of students with VI. The results of the present study might help stakeholders invest in teaching English to students with VI. Any organization responsible for students with VI or any foreign language institute, learning/teaching center, or school for students with VI might benefit from the findings of the present study. Teachers are also recommended to incorporate NVDA as a supplementary tool along with Braille to help foreign language students with VI foster their English language learning. The results can encourage teacher educators to offer some courses for pre-service teachers to get familiar with different AT devices and the way they can be utilized in inclusive classrooms.

The present study is not free from deficiencies. First of all, the participants of this study were beginners from a small sample of students with VI in a high school. Other levels of proficiency might lead to different results. The second limitation is that the participants

were limited to 22 learners. Furthermore, the experiment was limited to five sessions. Chances are that an experiment with an ideal number of participants and an adequate number of treatment sessions could have yielded a different pattern of findings.

Future studies are recommended to use other AT devices such as electronic Braille displays, screen magnifiers, refreshable Braille displays, Kurzweil, and touch tablets to assist the learning of students with VI. They should also investigate the role of NVDA or other AT devices in improving the spelling of students with VI, which seems to be another challenge for them (e.g., Papadopoulos et al., 2009).

References

Abner, G., & Lahm, E. (2002). Implementation of assistive technology with visually impaired students: Teachers' readiness. *Journal of Visual Impairment & Blindness, 96*(2), 98–110.

Abraham, C. H., Boadi-Kusi, B., Morny, E. K., & Agyekum, P. (2022). Smartphone usage among people living with severe visual impairment and blindness. *Assistive Technology*, 34, 611–618.

Alper, S., & Raharinirina, S. (2006). Assistive technology for individuals with disabilities: A review and synthesis of the literature. *Journal of Special Education Technology, 21*(2), 47–64.

Argyropoulos, V., Sideridis, G., Nikolaraiz, M., Martos, A., Padeliadu, S., Gkyrtis, K., & Koutsogiorgou, S. M. (2020). Refreashable Braille displays and reading fluency: A pilot study in individuals with blindness. *Education and Information Technologies*, *25*(5), 3613–3630.

Bhowmick, A. (2017). An insight into assistive technology for the visually impaired and blind people: State-of-the-art and future trends. *Journal on Multimodal User Interfaces, 11*(2), 149–172

Chandra, V., & Lloyd, M. (2008). The methodological nettle: ICT and student achievement. *British Journal of Educational Technology, 39*(6), 1087–1098.

Chen, Y. T. (2012). A study of learning effects on e-learning with interactive thematic video. *Journal of Educational Computing Research, 47*(3), 279–292.

Copley, J., & Ziviani, J. (2004). Barriers to the use of assistive technology for children with multiple disabilities. *Occupational Therapy International, 11*(4), 229–243.

Fichten, C. S., Asuncion, J. V., Barile, M., Ferraro, V., & Wolforth, J. (2009). Accessibility of e-learning and computer and information technologies for students with visual impairments in postsecondary education. *Journal of Visual Impairment & Blindness, 103*(9), 543–553.

Goldfus, C., & Gotesman, E. (2010). The impact of assistive technologies on the reading outcomes of college students with dyslexia. *Educational Technology, 50*(3), 21–25.

Higgins, E. L., & Raskind, M. H. (2004). Speech recognition-based and automaticity programs to help students with severe reading and spelling problems. *Annals of Dyslexia, 54*, 365–388.

Hussin, A. (2013). *Experiences of students with visual impairments in the adoption of digital talking textbooks: An interpretative phenomenological analysis* (Unpublished doctoral dissertation), Colorado State University, Malaysia.

Gkatzola, K., & Papadopoulos, K. (2022). Facebook usage and quality of life of individuals with visual impairments. *British Journal of Visual Impairment, 0*(0). https://doi.org/10.1177/02646196221117644

Gkatzola, K., & Papadopoulos, K. (2023). Social media actually used by people with visual impairment: A scoping review. *British Journal of Visual Impairment, 0*(0). https://doi.org/10.1177/02646196231189393

Jeno, L. M., Vandvik, V., Eliassen, S., Grytnes, J. A. (2019). Testing the novelty effect of an m-learning tool on interaction and achievement: A self-determination theory approach. *Computers & Education, 128*, 398–413.

Jitendra, A., Edwards, L. L., Sacks, G., & Jacobson, L. (2004). What research says about vocabulary instruction for students with learning disabilities. *Exceptional Children, 70*, 299–322.

Kapperman, G., Sticken, J., & Heinze, T. (2002). Survey of the use of assistive technology by Illinois students who are visually impaired. *Journal of Visual Impairment & Blindness, 96*(2), 106–108 .

Klingenberg, O. G., Holkesvik, A. H., & Augestad, L. B. (2019). Research evidence for mathematics education for students with visual impairment: A systematic review. *Cogent Education, 6*(1), 1–19.

Larsen-Freeman, D. (2013). Transfer of learning transformed. *Language Learning, 63*, 107–129.

Lee, H., & Templeton, R. (2008). Ensuring equal access to technology: Providing assistive technology for students with disabilities. *Theory into Practice, 47*, 212–219.

Mobaraki, M., Atash Nazarloo, S., & Tooshe, E. (2017). A comparative analysis of contracted versus alphabetical English Braille and attitudes of English as a foreign language learner: A case study of a Farsi-speaking visually impaired student. *Journal of Visual Impairment and Blindness, 111,* 471−474.

Özer, H. Z., & Cabaroğlu, N. (2018). Teaching vocabulary to visually-impaired EFL learners: A small scale study. *Çukurova Üniversitesi Eğitim Fakültesi Dergisi, 47*(1), 151–163.

Palaigeorgiou, G., & Papadopoulou, A. (2019). Promoting self-paced learning in the elementary classroom with interactive video, an online course platform, and tablets. *Education and Information Technologies, 24*, 805–823.

Papadopoulos, K. S., Arvaniti, E. K., Dimitriadi, D. I., Gkoutsioudi, V. G., & Zantali, C. I. (2009). Spelling performance of visually impaired adults. *The British Journal of Visual Impairment, 27*(1), 49–64.

Raskind, M. H., & Higgins, E. L. (1998). Assistive technology for postsecondary students with learning disabilities: An overview. *Journal of Learning Disabilities, 31*(1), 27–40.

Retorta, M. S., & Cristovão, V. L. L. (2017). Visually-impaired Brazilian students learning English with smartphones: Overcoming limitations. *Languages, 2*(12), 1–27.

Stein, V., Nesselrath, R., Alexandersson, J., & Tröger, J. (2011). *Designing with and for the visually impaired: Vocabulary, spelling, and the screen reader.* Paper presented at the 3rd International Conference on Computer-supported Education, Noordwijkerhout, Netherlands.

Susanto, S., & Nanda, D. S. (2018). Teaching and learning English for visually impaired students: An ethnographic case study. *English Review: Journal of English Education, 7*(1), 83–92.

Tallvid, M. (2016). Understanding teachers' reluctance to the pedagogical use of ICT in the 1:1 classroom. *Education and Information Technologies*, *21*(3), 503–519.

Wachiuri, R. N. (2015). The effectuality of the relative advantage of assistive technology on teaching and learning integrated English among the visually impaired learners in special secondary schools in Kenya. *International Journal of Scientific and Research Publications, 5*(9), 1–4.

Wong, M. E., & Cohen, L. (2011). School, family and other influences on assistive technology use: Access and challenges for students with visual impairment in Singapore. *British Journal of Visual Impairment, 29*(2), 130–144.

Zhang, Y. (2000). Technology and the writing skills of students with learning disabilities. *Journal of Research on Computing in Education, 32*(4), 467–478.

Zhang, D., Zhou, L., Briggs, R. D., & Nunamaker, J. F. (2006). Instructed video on learning effectiveness. *Information Management, 43*(1), 15–27.