

DOI: <https://doi.org/10.26529/cepsj.1426>

The Influence of Technology in Educating English Language Learners at-risk or with Disabilities: A Systematic Review

YIZHE JIANG*¹, QIAN WANG*² AND ZHENJIE WENG³

With the development of technology, the quantity and quality of electronic devices for students learning English as a second or foreign language (ESL/EFL) are on the rise, especially since the outbreak of the Covid-19 pandemic. To facilitate practices in English language education for students with special needs, the researchers conducted a systematic review of the empirical studies of technology tools for ESL/EFL students with learning difficulties published in the previous two decades. This paper presents the study selection process and findings of the review based on 16 peer-reviewed journal articles and one book chapter. The paper reveals the frequent mental and physical difficulties of English language learning and the typical technology tools employed in and out of class. More importantly, this paper discusses the roles of these technology tools in students' English language acquisition, specifically their effects on student learning outcomes and the students' perceptions toward them. With limited primary sources, this paper calls for more attention to the use of technology in English language learning of ESL/EFL students identified as at-risk and with learning disabilities and raises some implications for future research and instructional practices.

Keywords: educational technology, English language learners, learning difficulties, students with disabilities

1 *Corresponding Author. PhD candidate at the Department of Teaching and Learning, The Ohio State University, USA; jiang.1878@osu.edu.

2 PhD candidate at the Department of Teaching and Learning, The Ohio State University, USA.

3 Language and Culture Center, Duke Kunshan University, China.

Vpliv tehnologije pri poučevanju angleščine ogroženih učencev ali učencev s posebnimi potrebami: sistematični pregled

YIZHE JIANG, QIAN WANG IN ZHENJIE WENG

☞ Z razvojem tehnologije in zlasti po izbruhu pandemije covid-19 naraščata količina in kakovost elektronskih naprav za učence, ki se učijo angleščino kot drugi ali tuji jezik. Za lajšanje praks pri poučevanju angleškega jezika za učence s posebnimi potrebami so raziskovalci izvedli sistematičen pregled empiričnih študij, objavljenih v zadnjih dveh desetletjih, glede tehnoloških orodij, ki so na voljo učencem angleščine z učnimi težavami. Ta članek predstavlja postopek izbora gradiv in ugotovitve, ki so nastale na podlagi sistematičnega pregleda 16 recenziranih člankov in enega poglavja v knjigi. Prispevek razkriva pogoste duševne stiske in fizične težave pri učenju angleškega jezika ter tipične vrste tehnoloških orodij, ki se uporabljajo pri pouku ali zunaj njega. Še pomembneje, ta članek razpravlja o vlogah teh tehnoloških orodij pri usvajanju angleškega jezika učencev, zlasti o njihovih učinkih na učne izide in dojemanje orodij pri učencih. Z omejenimi primarnimi viri ta članek poziva k večji pozornosti rabe tehnologije pri učenju angleščine kot drugega/tujega jezika učencev, ki so opredeljeni kot rizični oz. z učnimi težavami, ter navaja nekatere možnosti za prihodnje raziskave in učne prakse.

Ključne besede: izobraževalna tehnologija, učenci angleščine, učne težave, učenci s posebnimi potrebami

Introduction

The use of technology has received great attention in research and the practices of education in the past few decades. As defined by Huang et al. (2019), educational technology is ‘the use of emerging and existing technologies to improve learning experiences in a variety of instructional settings, such as formal learning, informal learning, non-formal learning, lifelong learning, learning on demand, and just-in-time learning’ (p. v). In other words, it has been applied to a wide range of learning contexts both in and out of school. Since the outbreak of the Covid-19 pandemic, we have witnessed a growing body of research on educational technology as students have become more dependent on electronic devices, including computers, laptops, tablets, mobile phones, and so forth, which support them in taking lessons from home and communicating with others in every corner of the world (e.g., Al-Marouf et al., 2020; Hebebcı et al., 2020). In addition, with the rapid development of science and technology, more and more innovative devices and tools have been implemented in teaching and learning, including, in part, virtual reality, wearable devices, and robots, which encourage researchers and educators to explore their roles in education.

In the field of English as a second or foreign language (ESL/ EFL), technology has also gained great popularity, evidenced by numerous journal articles, book chapters, and dissertations on the subject. For example, a large-scale survey was conducted among Chinese undergraduate students reporting their strong motivation for learning English as a foreign language with the help of mobile-technology devices (Zou & Yan, 2014). A small-scale case study in a primary ESL class using a wiki for collaborating writing shows that such activity facilitates English writing in a creative way (Woo et al., 2011). Even though many publications have focused on technology uses for English language learners (ELLs), how technology tools facilitate students with special needs to learn English remains seldom explored. It is often more difficult for these students, defined as ELLs with learning difficulties owing to cognitive, physical, and sensorial impairments, to learn English compared with those in normal educational settings. Thus, to support these language learners academically, emotionally, and socially, much more research and practice in this realm are strongly in need. To keep abreast of the development of the research regarding applying various technology tools to English language education for students with special needs, we conducted a research synthesis on the empirical studies published as journal articles and book chapters. We adopt the classification of learning difficulties in Ganschow and Sparks’ (2001) review, which classifies this term into ‘learning disabilities’ and ‘at-risk’. While the former is based on the professional diagnoses of physical or

mental disabilities, such as hearing impairments and autism spectrum disorders, the latter refers to the inordinate difficulties in language learning at school, such as failure to pass exams. It is our hope to call for more attention to this special group of students and generate some implications of selecting appropriate English learning technology tools and implementing them in instrumental ways for teachers and students in special education contexts. Our review sets out to answer the questions: (1) How did technologies influence ESL/EFL students with special needs in reading? (2) How did technologies influence ESL/EFL students with special needs in vocabulary acquisition? (3) What are the students' perceptions toward their learning experiences with technology tools?

Our paper commences with a review of the research literature about technology for special education and ESL/EFL students with disabilities, followed by the details of the methodology regarding data collection and data analysis of the empirical sources. Next, we present the findings of this research synthesis, highlighting the roles of the technology tools involved in the 17 selected studies, highlighting how the technologies influence the students' English learning outcomes and how the students perceive their learning experiences with the technologies used in and out of the English class. We then discuss the limitations of the existing research and the implications for future research and practices of applying technology to the English language education of students with special needs.

Literature Review

Technology for Special Education

Drawing upon education legislation in the United States, students with disabilities should be offered complete learning materials and utilities in the course curriculum. The No Child Left Behind (2001) specifically requires that all students with disabilities need to receive 'content-based instruction and make progress in academics' (Evmenova & Behrmann, 2014, p. 27). In doing so, technology plays a substantive role in achieving the goal of fostering academic success for students with disabilities. Especially with the rapid advancement of technology, a variety of new devices and programmes have been created to assist students with disabilities in overcoming their learning barriers. Assistive technology (AT) and instructional technology (IT) are viewed as the most effective types that contribute to language literacy, different disciplines, and emotional and behavioural engagement for students with disabilities (Alnahdi, 2014; Evmenova & Behrmann, 2014).

According to Akpan and Beard's (2013) definition, 'AT is any item, piece of equipment, or product system that is used to increase, maintain, or improve

functional capabilities of individuals with special needs' (p. 114, cited by Disabilities Educational Act Amendments). Numerous researchers (e.g., Hecker et al., 2000; Raskind & Higgins, 1995) have witnessed its effectiveness, specifically in language reading and writing. Hecker et al.'s (2002) semester-long study assessed the efficiency of Kurzweil 3000, a text-to-speech programme, in reading comprehension of post-secondary students with attention disorders. According to the results of the questionnaire, at the end of the semester, nearly 80% of the students reported higher reading speed, fewer distractions, and less stress under the condition of reading with this software tool. In Raskind and Higgins's study (1995) on the proofreading efficiency of post-secondary students with learning disabilities, the group with a computer-based speech synthesis system detected 35% of total errors in compositions, whereas the group with another person reading aloud the text and the group with no assistance respectively found 32% and 25% of the errors.

Parallel to AT, IT has also been employed with a supplementary effect. According to Ozguc and Cavkaytar (2014), IT is defined broadly and generally referring to the 'developing instructional materials consistent with teaching methods' (p. 52), such as the SMART Board, projection, and Microsoft Office software. For instance, in Campbell and Mechling's study (2009), the SMART Board as a 'large, interactive whiteboard with touch-sensitive screen' (p. 49) and a 3-second constant time delay procedure were applied to teach letter sounds to three kindergarten students with learning disabilities. According to the results of observational learning and incidental learning, the IT technology facilitated the students in acquiring their target letter sounds and learning some of the other students' target letter sounds.

English language learners with special needs

As Baca and Cervantes (1989) describe, while ELLs face great hurdles at school, ELLs with special needs have to mount much greater challenges to achieve school success. Similarly, in EFL contexts, it is very challenging for students with special needs who have already been struggling with their first language acquisition due to physical, mental, and cognitive disabilities. Furthermore, what adds to this complex picture is that many ELLs with disabilities are from low socioeconomic family backgrounds. Thus, it is particularly important for schools and our society to provide them with various supports both in and out of the classroom. However, according to Maxwell and Shah (2012), schools and teachers usually face great challenges in assessing ELLs' special needs. 'The heart of the problem,' they describe, 'is discerning whether students are simply struggling with acquiring English or truly have disabilities that are impeding

their progress' (Maxwell & Shah, 2012, para. 7). As reported by the investigation of Karvonen et al. (2021), many teachers need support from scholars and families to identify English students with disabilities and further provide appropriate and professional instructions.

Many scholars have provided constructive guidance for teaching English to students with special needs. For instance, Hoover and Collier (1989) emphasise the learning materials in alignment with students' specific language proficiency, learning ability, and cultural heritage. Echeverria and McDonough (1993) suggest we create meaningful language learning contexts and pay attention to the cultural and linguistic assets that students bring to the classrooms. de Valenzuela and Niccolai (2004) contend that native language support is beneficial for these students learning second languages. García and Tyler (2010) encourage teachers to lessen the information that students have to generate independently. These recommendations can also be applied to selecting and using technology tools for ELLs with disabilities.

Though of great importance, to our surprise, there is a dearth of data on ELLs with special needs, as pointed out by Artiles and Klinger (2004). Through searching limited empirical data in this area, we have found that the extant studies often centre on students' development in English reading and vocabulary. For example, Swanson et al.'s study (2006) shows that the performance of English reading and working memory of students identified as having reading disabilities are significantly below the performance of students not at risk. A recent study by Knaak et al. (2021) indicates that ELLs with learning disabilities profit from storytelling, flashcards, and rewarding mechanisms in vocabulary learning. Other language skills and competences of these students, however, remain largely unknown. Hence, in the future, we expect to see more studies about various language learning areas, such as speaking, listening, and grammar.

Method

Research synthesis, a relatively new research method, 'investigate[s] and evaluate[s] past findings in a systematic fashion, always explicating the methodology followed in the review so as to enable replication by other reviewers' (Ortega, 2015, p. 225). Ortega (2015, pp. 233–234) specifically identified four steps in doing research synthesis:

- Problem specification
- Literature search and study eligibility criteria
- Coding book development
- Coding of studies

As the problem has been stated above, in the following section, we continue to discuss the literature search and analysis.

Literature Search

There are three processes involved in this source search. We first conducted a comprehensive search of the scholarly literature using a variety of research databases, including Google Scholar, ERIC, Scopus, Web of Science, Ebscohost, and Academic Search Complete. In this stage, a combination of keywords regarding three aspects were employed: educational technology, English language education, and students at-risk or with disabilities. We also consulted the lists of references of selected articles and existing literature reviews. Following the focus of the study, we initially only collected empirical research that discusses technology use in ESL or EFL education for students at-risk and with learning difficulties rather than studies that reviewed literature (e.g., Hockly, 2016; Liu et al., 2013), were conducted in language arts class (e.g., Benmarrakchi et al., 2016; Srivastava & Gray, 2012), and focused on other content classes (e.g., Terrazas-Arellanes et al., 2018). We, therefore, eliminated 41 articles or book chapters from our initial reading list as they did not focus on technology use, ESL/EFL learning, or students with special needs.

Our inclusion criteria are based on the following: (1) the study emphasised the focus of the synthesis; (2) the study was empirical; (3) the study was published in a peer-reviewed journal or published as a book chapter, and (4) the article was published in English. The exclusion criteria include (1) the study was not on ELLs with special needs and technology use in educating the students; (2) the study was a theoretical piece or literature review; (3) the study was published as a conference proceeding or newsletter; and (4) the study was published in another language. Our research was not limited to any particular timeframe or geographical location; hence, the criteria resulted in an international sampling of research on technology use in educating students with disabilities in second or foreign language learning. In total, these criteria resulted in the inclusion of 13 articles, including those of Doughty et al. (2013) and Ludwig (2018). Although the student participants in those two studies were not all disabled, they clearly mentioned that some of their student participants had disabilities. As 13 articles are a very small amount of literature, to enhance the findings of the study, we decided to search in the following targeted journals:

- Journal of Special Education Technology
- Assistive Technology Outcomes and Benefits
- British Journal of Special Education

- Information Technology and Disabilities E-Journal
- International Journal of Disability, Development, and Education
- International Journal of Special Education

Through the targeted search, we found four more pieces of literature. Therefore, we collected 17 sources in total for this review (Alemi & Bahramipour, 2019; Alison et al., 2017; Andujar & Nadif, 2020; Chai et al., 2016; Chiang, & Liu, 2011; Fawcett & Lynch, 2000; Guardino et al., 2013; Jozwik & Mustian, 2019; Liontou, 2019; Ludwig, 2018; Papadima-Sophocleous & Charalambous, 2014; Rivera et al., 2014; Rivera et al. 2013; Savvidou & Loizides, 2016; Ting, 2014; Wicha et al., 2012; Xin & Affrunti, 2019).

Data Analysis

We took the selected sources ($n=17$) as the basis of our analysis. These studies were analysed regarding their (1) mental and physical difficulties of English language learning, (2) the typical types of technology tools employed in and out of class, (3) major findings on the effectiveness of using technology in facilitating students' reading and writing practices, and (4) major findings on the effectiveness of using technology in facilitating students' vocabulary acquisition, and (5) students' perceptions toward their learning experiences with technology tools. Based on these categories, we created tables to organise the data. To conclude this section, Table 1 summarises the most basic information regarding each primary study.

Table 1

Basic Information of the Selected Studies.

Studies	Types of study	Research Contexts	Student Participants	Disabilities	Technology
Alemi & Bahramipour (2019)	Journal article	Iran	10 adult learners	Down syndrome	Humanoid robot as a teaching assistant
Alison et al. (2017)	Journal article	The United States	Three elementary students	Autism spectrum disorder	iPad 21 using the GoTalk NOW (Attainment Company, 2012) application
Andujar & Nadif (2020)	Journal article	Spain	39 students in two secondary schools	Six participants who suffered from physical and cognitive disabilities: hearing loss, attention deficit hyperactivity disorder (ADHD), and Semantic-Pragmatic Disorder.	Edpuzzle was used as the learning management system (LMS) in which students viewed the videos

Studies	Types of study	Research Contexts	Student Participants	Disabilities	Technology
Chai et al. (2016)	Journal article	The United States	Three young ELLs with disabilities at a rural primary school	Speech and language impairments (SLI) and/or specific learning disabilities and/or developmental delays; one student had difficulty focusing on learning tasks	An iPad app named Touch Sound
Chiang & Liu (2011)	Journal article	Taiwan	15 high school students (all males)	Dyslexia	Kurzweil 3000 software 'include[s] word processing, reminders, and an optical character recognition system (technology that converts print documents into a form that can be read by a computer)' (p. 201)
Fawcett & Lynch (2000)	Journal article	The United Kingdom	Two secondary school children	Dyslexia	RITA, 'a computer-based literacy support system that assists, rather than replaces, the teacher in providing support tailored to each child's profile of reading attainments' (p. 50)
Guardino et al. (2014)	Journal article	The United States	Five hearing-loss students at a state school	Deaf and hard of hearing (DHH)	American Sign Language books on DVDs
Jozwik & Mustian (2020)	Journal article	The United States	Three elementary bilingual students	One with developmental delay; the other two with speech-language impairment; one student was diagnosed as at-risk in learning	Google platform (Read & Write for Google Chrome); digital story map graphic organiser
Liontou (2019)	Journal article	Greece	10 EFL students ranging from 9 to 12 years old	Attention deficit hyperactivity disorder (ADHD)	Computer-based activities, like computer-based quizzes, posting their wikis on a variety of topics
Ludwig (2018)	Journal article	Germany	28 secondary EFL students	One student was diagnosed with dyslexia, and one student was special needs not clearly stated	A mobile vocabulary-learning app named Socrative
Papadima-Sophocleous & Charalambous (2014)	Journal article	Cyprus	Eight university students	Special Learning Difficulties (SFD), like dyslexia, dyscalculia, attention deficit hyperactivity disorder (ADHD)	Voice Memo on iPod Touch
Rivera et al. (2014)	Journal article	The United States	A 10-year-old elementary student	A moderate intellectual disability	Multimedia shared stories on iPad created by the application iBook Author

Studies	Types of study	Research Contexts	Student Participants	Disabilities	Technology
Rivera et al. (2013)	Journal article	The United States	Two third-grade Mexican-American elementary students	Moderate intellectual disability	Three English and Spanish multimedia books created and adapted by Microsoft PowerPoint
Savvidou & Loizides (2016)	Book chapter	Cyprus	Young adults in higher education attending an English for specific purposes course	High-functioning disabilities, such as dyspraxia, dyslexia, dysgraphia, attention deficit disorder, articulation, learning difficulties and psychological problems	Assistive technology tools, like Google Drive, Google sites, PowerPoint, Prezi, Wordle, QR codes and Instagram, and more via laptops, iPads, and smartphones
Ting (2014)	Journal article	Taiwan	Two university students and a teaching assistant	The two students with hearing impediments, the teaching assistant with autism	An interactive whiteboard
Wicha et al. (2012)	Journal article	Thailand	Phase one: 18 primary school students Phase two: 141 primary school students	Hearing impairments	Two computer software tools: Total Communication with Animation Dictionary (TCAD) for Phase one and Total Communication with Animation Dictionary and Related Lexical Terms (TCAD+) for Phase two
Xin & Affrunti (2019)	Journal article	The United States	Five third-grade students	Learning disabilities or communication impairments	An iPad Application named Learning Touch, First Sight Word Pro

Findings

Based on our review, the main foci of the existing research are (1) the effectiveness of the technology used in English language education for students with difficulties regarding their reading skills and vocabulary acquisition and (2) the students' perceptions toward their learning experiences with these technology tools. Therefore, our findings are constructed based on these two aspects. The first two research questions are related to learning outcomes, and the third is about learners' perceptions.

Research Question 1:

How did technologies influence ESL/EFL students with special needs in reading?

Among the 17 identified studies, four research studies were conducted on students' reading skills (Alison et al., 2017; Fawcett & Lynch, 2000; Jozwik

& Mustian, 2020; Papadima-Sophocleous & Charalambous, 2014). We organise this section based on the types of technology tools. In the year 2000, well before the widespread use of smartphones and tablets, Fawcett and Lynch conducted a controlled study to investigate how two secondary ESL students with dyslexia or other learning difficulties would benefit from the RITA system, a multimedia system installed in Apple Macintosh computers with pictures, graphs, and computer-synthesised or human speech in addition to the texts. After the training session and the ten-week group work with the multimedia system, the two students did not report significant improvement in their reading fluency and accuracy, despite their high motivation of using the tool. One student showed slight progress through pre-and post-tests, whereas the other student was further behind on standardised spelling tests. This study was an early attempt to assess the effectiveness of the technology tools regarding ELLs' reading development. While this study did not indicate the strong effect of the technology tools on ELLs with learning difficulties, the other two studies reported disabled ELLs' reading improvement in different areas.

Focusing on oral reading fluency, Papadima-Sophocleous and Charalambous (2014) assessed the effectiveness of an application on an iPod touch device named Voice Memo. In contrast with the group work in Fawcett and Lynch's research (2000), ELLs with learning difficulties worked independently with the software tool after class. The participants were eight EFL university students diagnosed with special learning difficulties. They were required to listen to and repeat the text in the video form with the application. After the eight-week intervention of repeated reading, a moderate growth in reading rate and prosody was detected.

In Jozwik and Mustian's project, three ESL students with language impairment or developmental delays read the texts with Read&Write, an extension on the Google Chrome web browser installed on their Google Chromebooks. This extension featured voice typing and word prediction. In addition to the Google platform, the researchers provided a digital story map and static cling boards with stickers representing relevant objects, cartoons, and anime characteristics among students. The study reported remarkable improvement in students' reading motivation and accuracy.

Research Question 2:

How did technologies influence ESL/EFL students with special needs in vocabulary acquisition?

According to our synthesis, research focusing on how technology tools influence students' vocabulary acquisition was the most frequently studied,

involving ten empirical studies (Alemi & Bahramipour, 2019; Alison et al., 2017; Chai et al., 2016; Guardino et al., 2014; Ludwig, 2018; Rivera et al., 2013; Rivera et al., 2014; Ting, 2014; Wicha et al., 2012; Xin & Affrunti, 2019). In order to facilitate the target students' vocabulary acquisition and retention, researchers in this area have implemented various types of technology tools, including applications on iPad or smartphones, multimedia books in English, students' native languages or sign language, computer-based learning systems, and robots as teaching assistants. The overall result of this area is mixed, discussed with the types of technology in the following.

Three studies in our database implemented applications on iPads. Chai et al.'s research (2016) focuses on phonological awareness. Three ESL elementary students with impairments of speech, communication, attention, or language participated in the programme. Learning with the application named 'Touch Sound' for three days, they mastered the target phonemes and learned additional vocabulary knowledge with the vocabulary models. After three weeks, the delayed test shows that they were able to generate vocabulary learning skills with various English materials and maintained these skills. For example, one of the participants achieved 100% of accuracy for two sets out of three of correcting his target phonemes and 83.33% accuracy for the other set at the third-week follow-up. Alison et al.'s study (2017) invited three ESL elementary students with autism spectrum disorders to read shared English stories on the application, GoTalk NOW, embedded with definitions and example sentences for the target words. Assisted by this application, all the participants mastered the target six words and maintained their vocabulary knowledge over time. According to the statistical graphs, one of the participants increased her independent corrections to both WH Parings (from 1.4 to 7.9) and comprehension questions (from 1.0 to 4.1). The last study was conducted by Xin and Affrunti (2019) with five ESL elementary students with learning disabilities or communication impairments. According to the researchers, an application called 'Learning Touch, First Sight Words Pro' was used for students learning vocabulary in class with flashcards including audio and visual information. With standardised tests, Xin and Affrunti (2019) assessed the participants' performance during baseline, intervention (eight weeks), and maintenance (one week later) regarding their development in word recognition, comprehension, and application. Their study reported that the participants' abilities in these three areas increased to a great extent and were maintained after the instruction. In general, the percentage of students' correct responses increased from 29% to 57%, 23% to 37%, and 31% to 75%, respectively, in the three areas. All three studies with iPad applications appeared to have similar research designs and results since the participants

showed improvement from pre-test to post-test and presented relatively high scores in the maintained test.

Three studies examine multimedia books instead of applications for learners to study vocabulary. In 2014, Rivera et al. investigated the effectiveness of shared multimedia storybooks in English and Spanish for an ESL elementary student from Panama diagnosed with an intellectual disability (ID). The participant's English vocabulary increased steadily through the intervention phase as he improved a mean of 4.8 correct words within a range of one to nine. Moreover, according to the questionnaire and interview, the instructor stated that such a learning process was engaging for the student. No assessment for the word maintenance was reported in their article. Rivera et al.'s programme (2013) invited two elementary Mexican-American students with moderate ID to study English vocabulary with the English and Spanish multimedia shared storybooks on iPad. The study delivered conflicting results. Within the two-week intervention, the participant showed great improvement since their mean scores of correct English words increased respectively from 1.2 to 13.6 and from 0.4 to 18. However, neither gained an exceptionally high score on measures of maintenance. In Guardino et al.'s study (2014), five EFL elementary students who spoke Spanish at home suffered from hearing loss and learned vocabulary with the assistance of a book presented in DVD format on iPads. Rather than written in Spanish, the book assisted students with American Sign Language. These students correctly signed 90% to 100% of the targeted vocabulary through the intervention, and the maintenance of the skills was also presented.

In Ludwig's project (2018), EFL secondary students with disabilities, such as dyslexia, used the smartphone application, Socrative, for learning vocabulary in eight weeks. According to the author, this application allowed teachers to upload their own learning content, generate quizzes, and follow the students' learning progress. Moreover, it was designed with translation from the learners' first language to English and a simple operating system that could save the learners' time in becoming familiar with the application. However, the number of students using this application decreased, and only 18% of them completed the learning journey. Therefore, this technology tool failed to facilitate the students' vocabulary learning in general. The implications for choosing and implementing the technology generated from this study are discussed later in this paper.

Using a computer to project visual information onto a board, the interactive whiteboard was applied to Ting's (2014) longitudinal research. Two EFL college students with hearing impairments attended the research, with a student with autism spectrum disorder acting as the teaching assistant. The

students learned the vocabulary in real settings and played games such as fill-the-blanks and crosswords with the interactive whiteboard. This indicated that such a technology tool improved students' vocabulary learning ability and made all the students more enthusiastic in the English classroom, especially in choosing their favourite colours and printing the answer with digital pressure (i.e., a touchscreen). Furthermore, the teaching assistant also found the whiteboard interesting and engaging for teaching. The study of Wicha et al. (2012) implemented another computer-based learning system with an e-dictionary for elementary EFL students with hearing loss from Thailand. This system was designed with seven ways of communication: Thai and English sign languages, fingerspelling, lip reading, images, reading, writing, and vocabulary. Two groups of participants with nine in each group, were enrolled in the first phase of this study. In terms of vocabulary learning ways, Group A used an e-dictionary system named Total Communication with Animation Dictionary (TCAD) while Group T followed the traditional ways of learning, such as translation of verbal language to sign language and flashcards. The t-value of the independent t-test calculation regarding the long-term post-tests of the two groups was 2.95, statistically different at the 95% confidence interval.

Given that no significant difference was found between the pre-test scores of the two groups, Group A remarkably outperformed Group T in vocabulary acquisition and retention. In the second phase of this project, an adapted e-dictionary system with situated learning (TCAD+) was used for 141 students to learn vocabulary. Students with this technology tool made great progress in maintaining their vocabulary. According to the researchers, only 25% of the students scored 15 out of 30 on the pre-test, while over 50% made it on the post-test. Moreover, during the two phases, the instructors observed that students proficient in operating computers often offered help to peers and teachers with limited computing skills, showing enthusiasm and collaboration in interacting with these technological tools.

Compared with the aforementioned studies based on computers and portable devices, Alemi and Bahramopour's (2019) study was a creative one in which the robot acted as an English teaching assistant. It echoed the rapid development of artificial intelligence and inspired our future research in language education with innovative technology. The study involved ten Iranian adult English learners with Down Syndrome who were struggling with both language learning and short-term memory. The robot in this project was installed with a text-to-speech engine and the functions of speech recognition as well as image recognition. In this study, five students learned English vocabulary in the traditional way while the other five students were assisted by the robot. According

to the independent sample t-test, there was a noticeable difference between the experimental group with the robot ($M = 12.40$, $SD = 1.51$) and the control group without the robot ($M = 8.4$, $SD = 1.81$) from the pre-test to the post-test. Also, Cohen's effect size of 2.36 was deemed a significant effect between those groups. Thus, it can be concluded that the students with the robot assistant outperformed their counterparts to a large extent in vocabulary learning, suggesting the wider use of artificial intelligence in the intersection of language learning and special education.

Research Question 3:

What are the students' perceptions toward their learning with technology tools?

Eight studies (Andujar & Nadif, 2020; Chiang & Liu, 2011; Jozwik & Mustian, 2020; Liantou, 2019; Ludwig, 2018; Rivera et al., 2014; Savvidou & Loizides, 2016; Xin & Affrunti, 2019) from our database discussed the students' perceptions toward their learning experiences with technology tools. In this section, we illustrate our findings based on students' positive and negative attitudes.

Students with disabilities spoke highly of different technology tools in boosting their language learning from different perspectives. Students with physical disabilities, hearing loss, and ADHD strongly confirmed the usefulness of Edpuzzle (a learning management system) in Andujar and Nadif's (2020) study. The researchers employed a questionnaire, the Technology Acceptance Model (TAM), to obtain quantitative data regarding satisfaction with the use of Edpuzzle. The descriptive statistics showed that 'the future use of the platform', 'the perceived ease of use', and 'the perceived usefulness' were evaluated as high mean scores, with $M = 4.83$, $M = 4.67$, and $M = 4.67$, respectively (p. 16). To further comprehend the students' perceptions towards the use of Edpuzzle, Andujar and Nadif (2020) conducted a structured interview. Drawing upon the in-depth interview, the students indicated that Edpuzzle provided easy steps to access the contents and the opportunities of rewinding the videos anytime and from any location. For instance, one of the participants illustrated that 'we find it very useful because we can watch the video several times at home' (p. 17).

The results were mirrored in Jozwik and Mustian's (2020) study that testified to the effectiveness of using a Google platform in language literacy for students with speech impairment. From the students' points of view, the Google platform made the learning procedure more manageable. Moreover, the students showed high motivation in their subsequent language learning. Through a baseline research design, the study also found 'increases in the number of words read correctly during technology-supported LEA instruction,

respective to baseline performance levels' (Jozwik & Mustian, 2020, p. 430). Savvidou and Loizides (2016) also examined Google platforms (e.g., Google Drive and Google Sites) and other technology tools (e.g., PowerPoint, Wordle, Prezi, and QR codes) with students who were suffering from dyspraxia, dyslexia, dysgraphia, attention deficit disorder, learning difficulties and psychological problems. Most of the participants stated that Google Drive and Google Sites had priority in storing different documents and files, which were the most practical and user-friendly. Prezi was voted the most 'attractive and memorable' (p. 416), and QR codes were chosen as the most pleasant and effective technological medium, with all students participating in the classroom activities. Other studies, including Liontou (2019), Ludwig (2018), Rivera et al. (2014), and Xin and Affrunti (2019), respectively illustrated a high level of satisfaction in using computer-based activities with ADHD, adopting a mobile vocabulary learning application with dyslexia, applying iPad multimedia shared story with moderate intellectual disabilities, and employing iPad App-learning Touch with learning disabilities. According to Liontou (2019), the majority of young ADHA students, including 30% of students who agreed and 40% of students who strongly agreed, perceived that online classes were more enjoyable and motivating than face-to-face classes. Further, it was also shown in the survey that 80% of the students felt that 'computer-based reading comprehension texts included annotated texts and electronic dictionary use' enabled ADHD students 'to overcome any vocabulary difficulties while processing their online texts or answering reading questions' (p. 227). In the research of Rivera et al. (2014), the only participant expressed that he enjoyed learning English vocabulary using iPad, with music and videos embedded in the stories as his favourite parts of learning. As reported by Xin and Affrunti's (2019) survey, 100% of the participants were willing to use iPads for vocabulary learning.

By contrast, according to these studies, students with disabilities also conveyed some negative attitudes toward technology tools in their language learning. Chiang and Liu (2011) conducted a qualitative study to investigate students' perceptions of the usefulness of the Kurzweil 3000 software. Drawing upon the data from interviewing their participants, the findings showed that even though the Kurzweil 3000, 'a talking computer with text-to-speech capabilities' (Chiang & Liu, 2011, p. 200), surely boosted students with dyslexia in reading comprehension, reading speed, vocabulary spelling, and pronunciations, the students still complained that the software did not provide a dictionary for translating English into Chinese. For this reason, the students might encounter difficulties while reading. Similarly, students with disabilities in Savvidou and Loizides's (2016) study also reported the obstacles in tracing

the words while using Wordle as one of the technology tools in their language learning.

In short, the application of technology tools certainly enhanced students with different disabilities in English language learning classrooms. According to our synthesis, some students described their dissatisfaction toward certain technology tools, such as Wordle, mostly due to the imperfect design of the tools. With the advancement of technology, we believe that students with learning difficulties will merit a higher level of enjoyment in their language learning.

Discussion

Pedagogical Implications

It is critical to recognise that language teachers need to choose appropriate technological tools for students with disabilities. Other than considering the tools with the easier login process and fewer distractions from some unnecessary online notifications, language teachers also need to think about the level of difficulty of the content for their students (Andujar & Nadif, 2020; Ludwig, 2018). In addition, while educating students with disabilities, the focus should be on their strengths rather than their deficiencies in order to strengthen their confidence in their ability to learn. For example, teachers can establish a communicative environment for students with learning impairments and autism by using visual-based resources to interact and improve their language abilities (Ting, 2014). In order to minimise possible anxiety while learning, it is also significant to define a suitable learning aim and provide assistance based on individual requirements.

Furthermore, the assignments to the students with disabilities should be tailored to students' cognitive and language abilities, with fewer questions per activity and shorter quizzes rather than longer assessments. Last but not least, both students and teachers require instruction on how to use technology in language courses. Teachers must make the process of using a new technological tool clear and well-organised for students with disabilities (Liontou, 2019).

Research Implications

The research implications based on this review are manifold. First, most selected studies were conducted only over a few weeks (e.g., Papadima-Sophocleous & Charalambous, 2014; Xin & Affrunti, 2019), whereas the long-term influences of these technology tools were hardly investigated. In the

future, much more longitudinal empirical studies are strongly in need. Second, as shown in Table 1, the sample sizes of the previous research were relatively small. For instance, Guardino et al.'s programme (2014) involved five students, and only three English language learners participated in Jozwik and Mustian's study (2020). Hence, we anticipate more empirical studies with larger sample sizes to provide guidance for a wide range of English language learning contexts involving students with learning difficulties. Third, regarding the target language skills, only reading ability and vocabulary were studied, which calls us to be attentive to other language skills and competences, such as listening, speaking, writing, and even cultural knowledge. Fourth, as language education technology is developing at an accelerating pace, we embrace the future with more innovative technologies to be studied, such as wearable devices and virtual reality technology tools. Moreover, what remains seldom discussed among these empirical studies is the ethical issues related to technology utilisation. As presented by Huang et al. (2019), while implementing research involving technology, we have to pay specific attention to the security and privacy of the data, since others might collect learners' usernames, passwords, and other personal information through the internet.

Conclusion

Taken together, this paper presents some key aspects of the current stage of the empirical research at the intersection of language learning technology and ESL/EFL students with special needs (i.e., the influences of technology on ESL/EFL students with special needs in reading and vocabulary acquisition, and students' perceptions toward their learning with technology tools). Not only does it review the main types of technology tools and learning difficulties investigated in the existing research literature, but also discusses the roles of these technology devices regarding the students' learning outcomes and their perceptions toward learning experiences assisted by technology. The benefits of these technology tools are well documented in the selected sources, in particular for English reading and vocabulary. However, we have heard a few different voices from the participants in some studies as they experienced inconveniences of using technology tools, such as the disturbance from the online messages and the lack of dictionary. Both the positive and negative roles of technology provide implications for our future practice and research design. It has to be pointed out that the sample size of this review is relatively small based on our selection criteria, and we do not centre on the methodology of the extant primary research. Future review works could fill these voids to deepen

our understanding of research on technology utilisation in English language education for students at risk or with disabilities.

References

- Akpan, J. P., & Beard, L. A. (2013). Overview of assistive technology possibilities for teachers to enhance academic outcomes of all students. *Universal Journal of Educational Research*, 1(2), 113–118. <https://doi.org/10.13189/ujer.2013.010211>
- Alemi, M., & Bahramipour, S. (2019). An innovative approach of incorporating a humanoid robot into teaching EFL learners with intellectual disabilities. *Asian-Pacific Journal of Second and Foreign Language Education*, 4(1). <https://doi.org/10.1186/s40862-019-0075-5>
- Alison, C., Root, J. R., Browder, D. M., & Wood, L. (2017). Technology-based shared story reading for students with autism who are English-language learners. *Journal of Special Education Technology*, 32(2), 91–101. <https://doi.org/10.1177/0162643417690606>
- Al-Marouf, R. S., Salloum, S. A., Hassanien, A. E., & Shaalan, K. (2020). Fear from COVID-19 and technology adoption: The impact of Google Meet during Coronavirus pandemic. *Interactive Learning Environments*, 1–16. <https://doi.org/10.1080/10494820.2020.1830121>
- Alnahdi, G. (2014). Assistive technology in special education and the universal design for learning. *The Turkish Online Journal of Educational Technology*, 13 (2), 18–23. <http://www.tojet.net/articles/v13i2/1322.pdf>
- Andujar, A., & Nadif, F. Z. (2020). Evaluating an inclusive blended learning environment in EFL: A flipped approach. *Computer Assisted Language Learning*, 35(5-6), 1138–1167. <https://doi.org/10.1080/09588221.2020.1774613>
- Artiles, A., & Klingner, J. (2006). Forging a knowledge base on English language learners with special needs: Theoretical, population, and technical issues. *Teachers College Record*, 108(11), 2187–2194. <https://doi.org/10.1177/016146810610801102>
- Baca, L., & Cervantes, H. (1989). *The bilingual special education interface*. Charles Merrill.
- Campbell, M. L., & Mechling, L. C. (2009). Small group computer-assisted instruction with SMART Board technology. *Remedial and Special Education*, 30(1), 47–57. <https://doi.org/10.1177/074193250815048>
- Chai, Z., Ayres, K. M., & Vail, C. O. (2016). Using an iPad app to improve phonological awareness skills in young English-language learners with disabilities. *Journal of Special Education Technology*, 31(1), 14–25. <https://doi.org/10.1177/0162643416633332>
- Chiang, H., & Liu, C. (2011). Evaluation of the benefits of assistive reading software: Perceptions of high school students with learning disabilities. *Assistive Technology*, 23(4), 199–204. <https://doi.org/10.1080/10400435.2011.614673>
- de Valenzuela, J. S., & Niccolai, S. L. (2004). Language development in culturally and linguistically diverse students with special education needs. In L. Baca & H. Cervantes (Eds.), *The bilingual special education interface* (4th ed., pp. 125–161). Merrill.

- Echevarria, J., & McDonough, R. (1993). *Instructional conversations in special education settings: Issues and accommodations*. National Center for Research on Cultural Diversity and Second Language Learning. <https://escholarship.org/uc/item/otqod3o4>
- Evmenova, A. S., & Behrmann, M. M. (2014). Communication technology integration in the content areas for students with high-incidence disabilities. *Assistive Technologies: Concepts, Methodologies, Tools, and Application*, 1, 26–53. <https://doi.org/10.4018/978-1-4666-4422-9.ch003>
- Fawcett, A. J., & Lynch, L. (2000). Systematic identification and intervention for reading difficulty: Case studies of children with EAL. *Dyslexia*, 6(1), 57–71. [https://doi.org/10.1002/\(sici\)1099-0909\(200001/03\)6:1<57::aid-dys163>3.0.co;2-w](https://doi.org/10.1002/(sici)1099-0909(200001/03)6:1<57::aid-dys163>3.0.co;2-w)
- Ganschow, L., & Sparks, R. (2001). Learning difficulties and foreign language learning: A review of research and instruction. *Language Teaching*, 34(2), 79–98. <https://doi.org/10.1017/S0261444800015895>
- García, S. B., & Tyler, B.-J. (2010). Meeting the needs of English language learners with learning disabilities in the general Curriculum. *Theory Into Practice*, 49(2), 113–120. <https://doi.org/10.1080/00405841003626585>
- Guardino, C., Cannon, J. E., & Eberst, K. (2013). Building the evidence-base of effective reading strategies to use with deaf English-language learners. *Communication Disorders Quarterly*, 35(2), 59–73. <https://doi.org/10.1177/1525740113506932>
- Hebebcı, M. T., Bertiz, Y., & Alan, S. (2020). Investigation of views of students and teachers on distance education practices during the Coronavirus (COVID-19) Pandemic. *International Journal of Technology in Education and Science (IJTES)*, 4(4), 267–282. <https://doi.org/10.46328/ijtes.v4i4.113>
- Hecker, L., Burns, L., & Katz, L. (2000). Benefits of assistive reading software for students with attention disorders. *Annals of Dyslexia*, 52(1), 1–17. <http://doi.org/10.1007/s11881-002-0015-8>
- Hoover, J. J. & Collier, C. (1989). Methods and materials for bilingual education. In M. Baca & H. T. Cervantes (Eds.), *The bilingual special interface* (pp. 231–255). Merrill.
- Huang, R., Spector, J. M., & Yang, J. (2019). *Educational technology: A primer for the 21st century*. Springer.
- Jozwik, S., & Mustian, A. L. (2019). Effects of technology-supported language experience approach for English learners with exceptional needs. *Reading & Writing Quarterly*, 36(5), 418–437. <https://doi.org/10.1080/10573569.2019.1655690>
- Karvonen, M., Clark, A. K., Carlson, C., Wells Moreaux, S., & Burnes, J. (2021). Approaches to identification and instruction for students with significant cognitive disabilities who are English learners. *Research and Practice for Persons with Severe Disabilities*, 46(4), 223–239. <https://doi.org/10.1177/15407969211040256>
- Knaak, T., Grünke, M., & Barwasser, A. (2021). Enhancing vocabulary recognition in English foreign language learners with and without learning disabilities: Effects of a multi component storytelling intervention Approach. *Learning Disabilities: A Contemporary Journal*, 19(1), 69–85.
- Liontou, T. (2019). Foreign language learning for children with ADHD: Evidence from a technology-enhanced learning environment. *European Journal of Special Needs Education*, 34(2), 220–235. <https://doi.org/10.1080/08856257.2019.1581403>

- Ludwig, C. (2018). Using vocabulary apps to enhance students' vocabulary knowledge. *Studies in Self-Access Learning Journal*, 9 (3), 306–323. <https://doi.org/10.37237/090305>
- Maxwell, L. A., & Shah, N. (2012, August 28). "Evaluating ELLs for Special Needs a Challenge". Education Week. <https://www.edweek.org/policy-politics/evaluating-ells-for-special-needs-a-challenge/2012/08>
- Ortega, L. (2015). Research synthesis. In B. Paltridge & A. Phakiti (Eds.), *Research methods in applied linguistics: A practical resource* (pp. 225–244). Bloomsbury Publishing.
- Özgüç, C. S., & Cavkaytar, A. (2014). Teacher use of instructional technology in a special education school for students with intellectual disabilities: A case study. *Turkish Online Journal of Qualitative Inquiry*, 5(1), 51–65. <https://doi.org/10.17569/tojqi.14394>
- Papadima-Sophocleous, S., & Charalambous, M. (2014). Impact of iPod touch-supported repeated reading on the English oral reading fluency of L2 students with specific learning difficulties. *The EuroCALL Review*, 22(1), 47. <https://doi.org/10.4995/eurocall.2014.3639>
- Raskind, M. H., & Higgins, E. (1995). Effects of speech synthesis on the proofreading efficiency of postsecondary students with learning disabilities. *Learning Disability Quarterly*, 18(2), 141–158. <https://doi.org/10.2307/1511201>
- Rivera, C. J., Mason, L. L., Moser, J., & Ahlgrim-Delzell, L. (2014). The effects of an iPad® multimedia shared story intervention on vocabulary acquisition for an English Language learner. *Journal of Special Education Technology*, 29(4), 31–48. <https://doi.org/10.1177/016264341402900403>
- Rivera, C. J., Spooner, F., Wood, C. L. & Hicks, S. C. (2013). Multimedia shared stories for diverse learners with moderate intellectual disability. *Journal of Special Education Technology*, 28(4), 53–68. <https://doi.org/10.1177/016264341302800405>
- Savvidou, G., & Loizides, F. (2016). Investigating commercially available technology for language learners in higher education within the high functioning disability spectrum. In S. Papadima-Sophocleous, L. Bradley, & S. Thouésny (Eds.), *CALL communities and culture – short papers from EUROCALL 2016* (pp. 413–417). Research-publishing.net. <https://doi.org/10.14705/rpnet.2016.eurocall2016.598>
- Swanson, H. L., Sáez, L., & Gerber, M. (2006). Growth in literacy and cognition in bilingual children at risk or not at risk for reading disabilities. *Journal of Educational Psychology*, 98(2), 247–264. <https://doi.org/10.1037/0022-0663.98.2.247>
- Ting, K. (2014). Multimodal resources to facilitate language learning for students with special needs. *International Education Studies*, 7(8). <https://doi.org/10.5539/ies.v7n8p85>
- Wicha, S., Sharp, B., Sureephong, P., Chakpitak, N., & Atkins, A. (2012). An animated dictionary for hearing-impaired students in Thailand. *Journal of Research in Special Educational Needs*, 12(4), 234–244. <https://doi.org/10.1111/j.1471-3802.2012.01239.x>
- Woo, M., Chu, S., Ho, A., & Li, X. (2011). Using a wiki to scaffold primary-school students' collaborative writing. *Educational Technology and Society*, 14(1), 43–54. <https://www.jstor.org/stable/jeductechsoci.14.1.43>
- Xin, J. F., & Affrunti, R. L. (2019). Using iPads in vocabulary instruction for English language learners. *Computers in the Schools*, 36(1), 69–82. <https://doi.org/10.1080/07380569.2019.1565888>

Zou, B., & Yan, X. (2014). Chinese students' perceptions of using mobile devices for English learning. *International Journal of Computer-Assisted Language Learning and Teaching*, 4(3), 20–33.
<https://doi.org/10.4018/ijcallt.201407010>

Biographical note

YIZHE JIANG is a PhD candidate in the field of Multilingual Language Education in the Department of Teaching and Learning at The Ohio State University, US. Her research interests involve multilingual language education, heritage language maintenance, translanguaging, assistive technology for language education, and learning Chinese as a foreign language.

QIAN WANG is a PhD candidate in the field of Multilingual Language Education in the Department of Teaching and Learning at The Ohio State University, US. Her research interests include second language reading and writing, argumentative writing in EFL contexts, automated writing evaluation, and writing teacher education.

ZHENJIE WENG, PhD, is an Assistant Professor in English Language in the Language and Culture Center at Duke Kunshan University, China. Her research focuses on second language writing, language teacher education, queer pedagogy in ELT, and translanguaging.