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Teaching Braille to Sighted Individuals through Technology: A Systematic Review[1]

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ABSTRACT

This study examined the studies on teaching braille to sighted individuals through technology. This systematic review study conducted research on Web of Science, ERIC, Academic Search Ultimate, Google Scholar, and Scopus. As a result of the search, 10 studies related to the subject were ultimately included. The researchers analyzed these studies through descriptive analysis. As a result of the research, it was determined that the studies examined were mainly conducted to introduce software or provide information/examine existing software or resources and evaluate the effect of a computer-based program. In addition, the researchers revealed that mostly single-subject design studies were conducted. Almost all the participants in the studies were undergraduate students. In all these studies, researchers collected data by recording within the software, braille, and printed reading passages and analyzed them primarily through graphical analysis. Moreover, it was revealed that there were more studies in which information about the software and the revisions made according to the test of the software were presented as qualitative findings. Finally, the studies reviewed were obtained through specific databases, specific keywords and word combinations. These studies were analyzed in the context of certain variables. In addition, it is limited to 10 studies published in a peer-reviewed journal, whose full text can be downloaded, whose target audience is sighted individuals, and which address technologies/software/hardware related to braille education.

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INTRODUCTION

For vision to occur, the eye, optic nerve, and brain must work together. A disorder/disruption in one of these can cause visual impairment. The causes of visual impairment are generally addressed before, during, and after birth (Aslan & Işıtan-Kılıç, 2023). At this point, it is possible to define visual impairment as partial or complete loss of vision that occurs before, during, and after birth (Ministry of National Education [MoNE], 2018). It is known that individuals with visual impairment may be delayed in many developmental areas, such as motor skills, cognitive development, etc., due to these deficiencies and may lag their sighted peers (Altunay et al., 2023; Gürel-Selimoğlu, 2021). However, individuals with visual impairment can catch up with their sighted peers by being supported with appropriate education (İşlek, 2020). It can be said that braille is one of the areas that should be supported for individuals with visual impairment.

Braille is a tactile writing system for individuals with visual impairments (Lee & Foo, 2010). Braille is based on symbols created by embossing six dots according to various combinations (Şafak, 2022). Braille consists of six embossed dots (3x2) in a rectangular shape with two columns and three dots in each column (Argyropoulos & Papadimitriou, 2017). The dots in the left column are numbered 1, 2, and 3, respectively, from top to bottom, and the dots in the right column are numbered 4, 5, and 6, respectively (Antonacopoulos & Bridson, 2004). These dots are used universally; thus, braille symbols such as letters, numbers, and punctuation marks in the braille writing system are formed (Koenig & Holbrook, 2000).

Since individuals with visual impairment cannot read printed writing, they do their reading-writing activities through braille. Braille is an important system that enables individuals with visual impairment to read and write and supports the development of literacy skills (Putnam, 2013). Individuals with visual impairment who can use braille effectively can independently perform many skills, such as preparing for exams, accessing information, participating in academic activities that require reading and writing, and performing daily tasks independently (Lupetina, 2022). In addition, it is stated that these individuals are more successful in various fields such as economy, employment, education level, and quality of life (Hatzigiannakoglou & Kampouraki, 2016; Ryles, 1996).

Learning braille is one of the essential elements of the education curriculum of individuals with visual impairment (Koenig & Holbrook, 1995). However, the literature states that the braille literacy rate of individuals with visual impairment is low (Dimitrova-Radojichikj, 2015). One of the reasons is the need for teachers with braille competence (Rahimi et al., 2018). Putnam and Tiger (2016) argue that no trained instructors can provide braille education in many schools. In addition, it is estimated that the braille competencies of teachers in various branches, such as mathematics, science, and social sciences, who teach individuals with visual impairment are also limited. Such a situation negatively affects the braille learning of individuals with visual impairment (Hatzigiannakoglou & Kampouraki, 2016). Therefore, it is mentioned that teachers should be familiar with braille to give quick feedback, make corrections, or adapt teaching materials to students with visual impairment during teaching (Bell, 2010). At the same time, teachers or prospective teachers need to know braille to support the academic skills of individuals with visual impairment, provide practical education, and carry out measurement and evaluation (Lee & Foo, 2010). It is even stated that beyond teachers, families with children with visual impairment also need to learn braille for some purposes, such as helping their children in their lessons and controlling what they do (Küçüközyiğit et al., 2021).

Since individuals with visual impairment cannot benefit from the sense of sight, they learn through their sense of touch (fingertips). However, the learning of braille reading by sighted individuals and individuals with visual impairment differs. Sighted individuals may not need to learn braille tactilely. In other words, sighted individuals should learn to read braille visually (Scheithauer & Tiger, 2012). However, sighted individuals may encounter some difficulties in learning braille. These difficulties

include the complex structure of braille, tactile awareness, and the limitations of practicing and receiving feedback (Aslan et al., 2024). Therefore, effective braille education systems and methods are needed for sighted individuals (Sasaki et al., 2007; Scheithauer & Tiger, 2012).

The literature emphasizes that many sighted individuals can learn braille when adequate motivation is provided and the proper methods are used (Bola et al., 2016). It is possible to exemplify these effective methods, such as presenting braille teaching with the support of technology, web-based or computer-aided braille teaching, and online braille educational software/systems. Some studies in the literature indicate that software or programs used in braille education are effective (e.g., Kapperman et al., 1996; Putnam & Tiger, 2015; Putnam & Tiger, 2016; Sasaki et al., 2007; Scheithauer & Tiger, 2012; Scheithauer et al., 2013). The use of websites or web-based programs in teaching braille to sighted individuals has many advantages, such as increasing interest in learning braille, facilitating learning, and being accessible from anywhere, in addition to improving the effectiveness of learning (Abd-Aziz et al., 2023). The ubiquitous accessibility of teaching braille to sighted individuals is a solution that can overcome the shortage of qualified instructors (Putnam & Tiger, 2015). Therefore, using computer-assisted applications and internet technologies to teach braille to sighted individuals is seen as promising (Lee & Foo, 2010). However, despite this vital situation, researchers point out that there are minimal studies on the use of technology in braille instruction (e.g., Hatzigiannakoglou & Kampouraki, 2016; Putnam & Tiger, 2015) and emphasize the need for more experimental research (Lee & Lee, 2021). The present descriptive study constitutes a review of studies on the use of technology in braille instruction. The objective of this study was twofold: firstly, to draw attention to the use of technology in braille teaching, and secondly, to present a descriptive picture for researchers working on braille. In accordance with this objective, the studies were analyzed according to the following criteria: a) purpose, b) research design, c) participants, d) data collection tool, e) data analysis, f) software/hardware, and g) findings variables.

METHOD

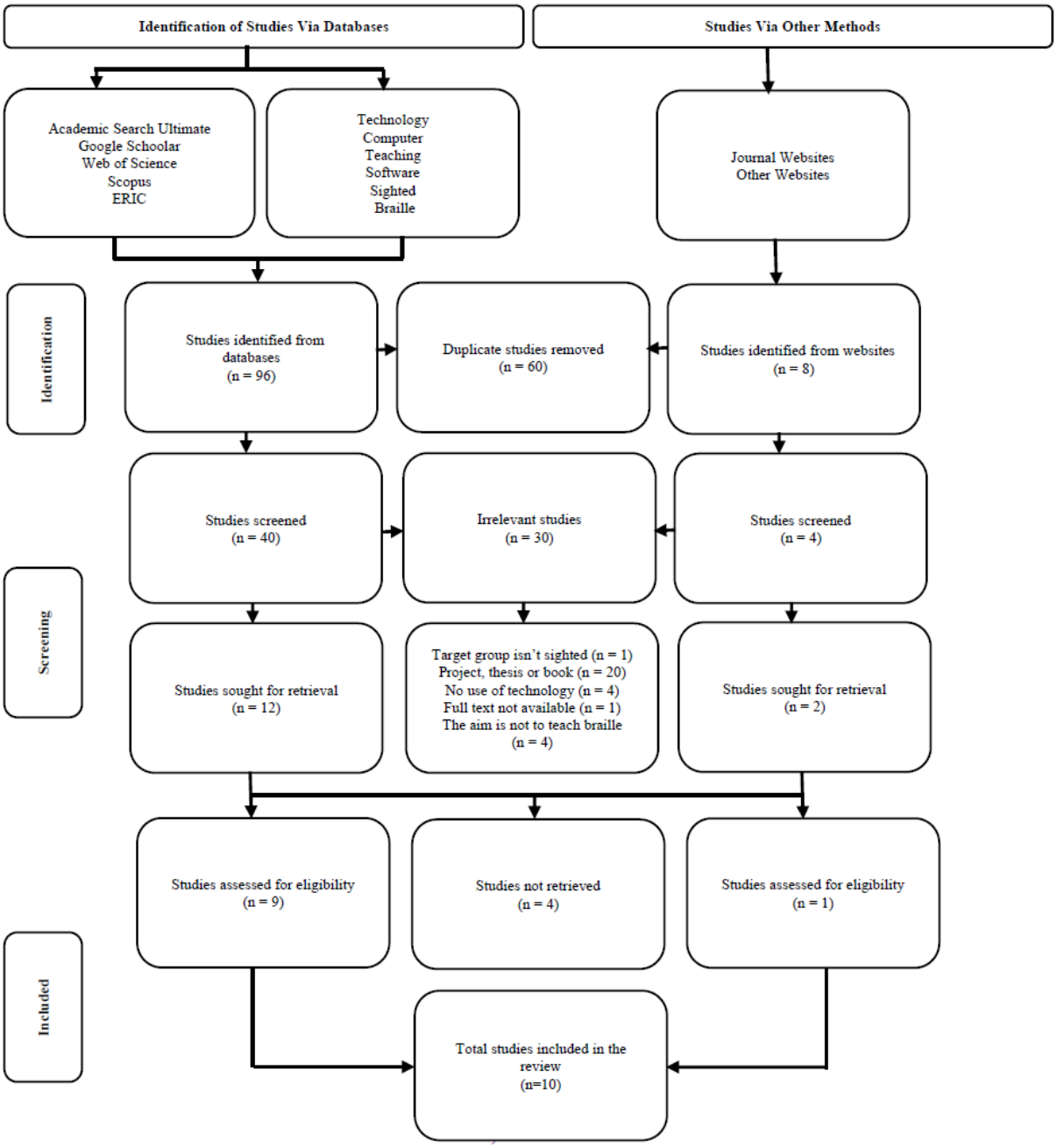
Research Design

This study is a systematic review. A systematic review examines predetermined studies according to specific criteria based on variables or research questions (Zawacki-Richter et al., 2020). Within the scope of this study, the researchers established some inclusion and exclusion criteria and examined the studies they reached in the context of various variables.

Literature Review

For the literature review in this study, the researchers followed the processes of a) identification, b) screening, and c) inclusion. They used the Web of Science, ERIC, Academic Search Ultimate, Google Scholar, and Scopus electronic databases to access relevant research for this systematic review. They searched for the keywords “braille,” “technology,” “sighted,” “computer,” “software,” and “teaching” and the word combinations “braille and technology,” “braille and sighted and technology,” “braille and computer,” “braille and software,” “braille and sighted,” “braille and teaching” and “sighted and braille and teaching.” As a result of their searches with the keywords and word combinations available in the databases mentioned above, they reached 104 studies that overlapped with the research topic. Then, they filtered the studies using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021).

Figure 1. *PRISMA flow diagram for the examined studies for systematic reviews*



The researchers set some inclusion and exclusion criteria to identify relevant studies. The inclusion criteria were that

a) The research was published in a peer-reviewed journal,

b) The full text of the research was available for download,

c) The target group of the research was sighted individuals,

d) The research addressed technologies/software/hardware related to braille instruction. (In this study, technology was considered any device, application, or platform with physical, hardware, or software features that improve individuals' braille skills or enable braille acquisition).

e) The exclusion criteria were that

1. The research did not involve technology in braille instruction (e.g., traditional tactile instruction),

2. The research was a conference paper, project report, thesis, or book chapter,

3. The full text of the research was not available,

4. The target group of the research was not sighted individuals (e.g., individuals with visual impairment), and

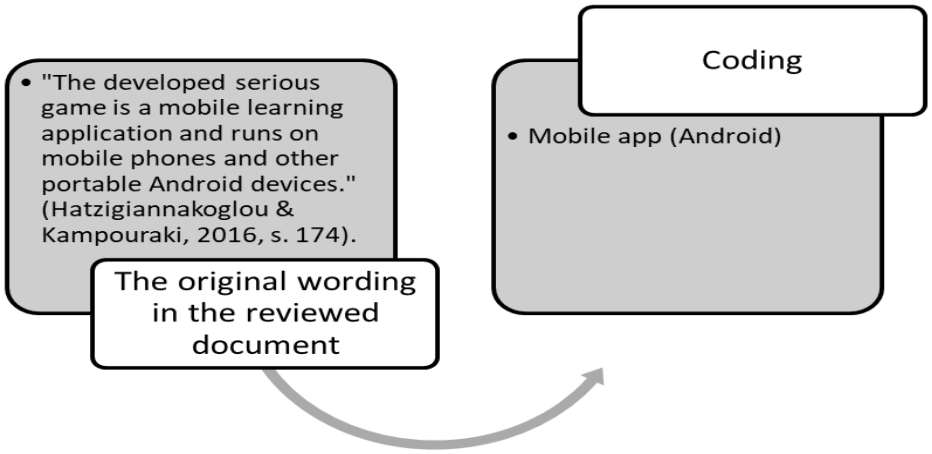
5. The purpose of research was unrelated to braille instruction (e.g., translation between braille and print).

6. The researchers compiled ten studies for detailed review based on these inclusion and exclusion criteria and the procedure they followed.

Data Collection

The researchers created a coding key to evaluate the ten studies analyzed in this study. The coding key was created through the variables described in the title of data analysis because descriptive analysis was used for data analysis. They coded the studies in the document pool using this coding key. This coding was done separately by two of the authors of the article. The sample coding for the "software/hardware" variable within the scope of the research is presented in Figure 2.

Figure 2. *An example of the coding made within the scope of the research*



Data Analysis

The researchers analyzed the studies obtained in this study through descriptive analysis. Descriptive analysis is explained as a type of analysis in which the data obtained are summarized and interpreted according to predetermined themes (Yıldırım & Şimşek, 2018). In this study, the researchers analyzed the related studies according to the variables of a) purpose, b) research design, c) participants, d) data collection tool, e) data analysis, f) software/hardware, and g) findings.

Validity and Reliability

In this research's context of reliability studies, firstly, two authors carried out electronic screening independently. As a result of these screenings, the percentage of agreement between authors was calculated as 100%. In addition, an inter-coder reliability calculation was made regarding the coding. In this calculation, the formula "Agreement / (Agreement + Disagreement) x 100" was used (Miles & Huberman, 2014). As a result of the calculation [26/(26+6) x 100] for 40% of the studies reviewed with the formula in question, an inter-coder reliability percentage of 81.25% was found. A value of 80% and above is considered sufficient (Miles & Huberman, 2014). In the context of validity studies, strategies were utilized by triangulation by involving at least two researchers in the collection, interpretation, and analysis of the data; detailed description through detailed reporting of the research process; and obtaining the opinion of an expert experienced in systematic review after the reporting of the findings was completed (Merriam, 1998).

Ethics

This research is a systematic review and therefore does not require ethical approval.

FINDINGS

Table 1. *Reviewed Studies*

Source	Purpose	Design	Participants	Data Collection	Data Analysis	Software	Findings
Kapperman et al. (1996)	Review of braille and computer-assisted braille transcription programs for sighted individuals and presentation of the description, manual, and field test results of The Computerized Braille Tutor	-	4 teachers 2 students 2 families 2 counselors	Proficiency test Correction exercises Braille translation	Qualitative and quantitative analysis	MS DOS-based software	Information about the computerized braille tutorial is included. In addition, according to the data obtained from 10 sighted people, some arrangements were made with the software.
Sasaki et al. (2007)	Detailed description of the self-learning system of Braille reading and writing and presentation of results data	-	1 student	Log records	-	Computer-based learning system	Information about the developed system is given. As a result of the three-month experiment of the system, the average time per braille character input was reduced by approximately 30-50%, which shows the effectiveness of both the reading and writing subsystems.
Lee & Foo (2010)	Designing a web-based learning system for teaching, facilitating, and supporting the learning of braille code for sighted individuals	Multidisciplinary team approach	Teachers Teacher candidates Families	Checklist Ranking test Braille translation Self-assessment	-	Web-based learning system	The web-based learning system was introduced and stated to be under development.
Scheithauer & Tiger (2012)	Preliminary evaluation of a computer-based program that aims to teach the relationship between Braille	Multiple baseline design	4 teacher candidates	Braille reading text Oral reading fluency test Letter recognition test	Graphical analysis	Computer-based learning program	Participants became adept at matching visual braille with printed words. They also increased the number of braille words they read. These were

	characters and English letters using a matching-to-sample format						maintained in the maintenance probes.
Scheithauer et al. (2013)	Comparing the effectiveness and efficiency of the program using two different response formats on a larger sample	-	81 teacher candidates	Braille reading Braille letter recognition Social validity questionnaire Demographic information form	t-Test	Computer-based learning program	Both response formats increased braille letter recognition and braille reading. In addition, similar results were obtained in the follow-up sessions. High questionnaire averages were obtained in terms of social validity.
Putnam & Tiger (2015)	Teaching braille letters, numbers, punctuation marks, symbols, and contractions to sighted individuals	Multiple probe design	4 teacher candidates	Log records Braille reading text Oral reading fluency test	Graphical analysis	Computer software (VBT)	The training was partially practical in recognizing braille characters. Also, participants' braille reading increased but did not reach fluency levels in all cases.
Putnam & Tiger (2016)	Evaluation of the effects of teaching the relationship between Braille characters and printed letters on various variables	Multiple probe design	4 teacher candidates	Braille translation Braille reading text Oral reading fluency test	Graphical analysis	Computer software (VBT)	Although the program improved some skills positively, more was needed in all modules. There was also an increase in the skills of transcribing braille sentences and braille reading fluency.
Hatzigiannakoglou & Kampouraki (2016)	Giving information about the game developed to teach the Braille alphabet	Experimental	-	Games	-	Mobile app (Android)	A new software on braille alphabet learning for sighted individuals is presented.
Lee & Lee (2021)	Examining the success indicators measured on the MOOC platform, course completion rates and perceptions of course quality	-	69 teacher candidates	Braille test Course completion rate Log records Perception scale	Descriptive	Web-based learning system (MOOC)	It was determined that at least 85.5% of the students could learn braille codes and had a positive perception; however, it was stated that the course completion rate of the students was low.
Abd Aziz et al. (2023)	Development of a Braille learning website,	Qualitative	-	Document	Document analysis	Website	There are two websites for learning Braille: eKodBrailleBM

	examining its use and function	and eBrailleHjjaiyyah .

Purpose Findings

When the reviewed studies are examined according to their purposes, it is seen that most of the studies (n=5) addressed the development/design or introduction of a system related to braille teaching (Abd Aziz et al., 2023; Lee & Foo, 2010; Sasaki et al., 2007), game development (Hatzigiannakoglou & Kampouraki, 2016), and review of existing programs (Kapperman et al., 1996). The remaining studies (n=5) focused on braille instruction and evaluated the programs' effects (Lee & Lee, 2021; Putnam & Tiger, 2015; Putnam & Tiger, 2016; Scheithauer & Tiger, 2012; Scheithauer et al., 2013).

Research Design Findings

When the related studies are evaluated in terms of the research designs, they used, it comes to the fore that single-subject designs were mainly used (n=3). Two of these studies (Putnam & Tiger, 2015; Putnam & Tiger, 2016) used a multiple probe design, and one (Scheithauer & Tiger, 2012) used a multiple baseline design. In addition, one study used a qualitative design (Abd Aziz et al., 2023), another used an experimental (Hatzigiannakoglou & Kampouraki, 2016), and another used a multidisciplinary team approach (Lee & Foo, 2010). In addition, no clear information was given regarding the design used in four studies (Lee & Lee, 2021; Sasaki et al., 2007; Scheithauer et al., 2013; Kapperman et al., 1996).

Participant Findings

When the studies were reviewed, it was determined that they generally focused on pre-service teachers (Lee & Lee, 2021; Putnam & Tiger, 2015; Putnam & Tiger, 2016; Scheithauer & Tiger, 2012; Scheithauer et al., 2013). In addition, some studies deal with teachers (Kapperman et al., 1996) and students (Sasaki et al., 2007) as target groups. In terms of explaining the characteristics of the study groups (e.g., age, gender), it was noteworthy that very few studies included this information. One study included general statements about the participants (e.g., teacher, family), while no number was given (Lee & Foo, 2010). In two studies (Abd Aziz et al., 2023; Hatzigiannakoglou & Kampouraki, 2016), there was no participant information in these studies, as they dealt with purposes such as providing information about braille instruction and introducing the use of the system.

Data Collection Findings

When the related studies were reviewed, researchers used different data collection tools. It is noteworthy that the researchers frequently used data collection tools such as braille translation/braille text reading (Kapperman et al., 1996; Lee & Foo, 2010; Putnam & Tiger, 2015; Putnam & Tiger, 2016; Scheithauer & Tiger, 2012; Scheithauer et al., 2013), log records (Lee & Lee, 2021; Putnam & Tiger, 2015; Sasaki et al., 2007), oral reading fluency (Putnam & Tiger, 2015; Putnam & Tiger, 2016; Scheithauer & Tiger, 2012; Scheithauer et al., 2013). In addition, data collection tools such as proficiency tests (Kapperman et al., 1996), perception scales (Lee & Lee, 2021), checklists (Lee & Foo, 2010), and letter recognition tests (Scheithauer & Tiger, 2012) were also used.

Data Analysis Findings

The data analysis techniques in the studies examined within the scope of this research varied. For example, three studies analyzed data through graphical analysis (Putnam & Tiger, 2015; Putnam & Tiger, 2016; Scheithaue & Tiger, 2012). In addition, the t-test, one of the parametric analysis methods, was used in one study (Scheithauer et al., 2013). Lee & Lee (2021) used descriptive statistics, while Abd Aziz et al. (2023) used document analysis. Although Kapperman et al. (1996) mentioned qualitative and quantitative data analysis techniques, they needed to clearly state which techniques they used. Data analysis was not provided in some studies since the purpose of introducing, informing, and designing the system was addressed (Hatzigiannakoglou & Kampouraki, 2016; Lee & Foo, 2010; Sasaki et al., 2007).

Findings Related to Software

The software used in the studies reviewed within the scope of this research varied. For example, one study stated that MS-DOS-based software was used (Kapperman et al., 1996). Another study mentioned an Android-based mobile application (Hatzigiannakoglou & Kampouraki, 2016). Similarly, another study focused on websites for teaching braille (Abd Aziz et al., 2023). In some studies, web-based learning systems (e.g., MOOC) concerning braille teaching have been the subject of (Lee & Foo, 2010; Lee & Lee, 2021). In most of the reviewed studies (n=5), it was determined that computer software (e.g., VBT) or computer-based learning systems were used for braille instruction (Putnam & Tiger, 2015; Putnam & Tiger, 2016; Sasaki et al., 2007; Scheithauer & Tiger, 2012; Scheithauer et al., 2013).

DISCUSSION

The researchers reviewed the studies on teaching braille to sighted individuals through technology in this study. Thus, the aim was to draw attention to the use of technology in braille teaching and to present a descriptive picture for researchers working on braille. In this context, ten studies that met the inclusion criteria of the study were analyzed according to a) purpose, b) research design, c) participants, d) data collection tool, e) data analysis, and f) software/hardware variables. The researchers discussed the data obtained within the framework of the literature.

It is essential for sighted individuals, especially teachers, to know braille for various purposes, such as preparing materials for students with visual impairments, providing feedback and correction, supporting their academic skills, and providing effective teaching (Bell, 2010; Lee & Foo, 2010). In this respect, preparing teachers for braille is an important research area (Lillie & Tiger, 2019). The literature suggests that sighted individuals can learn braille with sufficient motivation and appropriate methods (Bola et al., 2016). It is essential to use various easily accessible software or teaching programs during braille teaching (Putnam & Tiger, 2015). The software used in the reviewed studies also varied. For example, it was also determined that web-based or computer-based learning systems, such as MS-DOS-based or Android-based software, were used. Different software forms can be encountered since the year range was not defined in the reviewed studies. Considering that MS-DOS-based software is somewhat older, Android-based mobile applications are more frequently the subject acquired. Some studies in the literature (e.g., Hoskin et al., 2024; Subakan & Koç, 2019) show that various software and mobile applications are used. This can be considered a feature that overlaps with this research regarding the variety of software used. In addition, it is noteworthy that the studies reviewed within the scope of the research were conducted for different purposes, such as designing a system for teaching braille to sighted individuals, examining existing programs, developing games, and evaluating the system's effectiveness. Therefore, it is possible to come across studies conducted on teaching braille to sighted individuals for different purposes. These studies indicate that effective braille teaching to sighted individuals can be achieved through web-based or computer-aided/technology-supported braille teaching.

Advances in technology can offer new opportunities to access braille (Martiniello et al., 2018). However, sighted individuals may experience various difficulties in learning braille. For example, one of these difficulties is braille's tactile and complex structure, which limits practicing and receiving feedback (Aslan et al., 2024). On the other hand, the lack of trained trainers with braille competence to provide braille education can be expressed as another limitation (Kana & Hagos, 2024; Putnam & Tiger, 2016; Rahimi et al., 2018). Lillie & Tiger (2019) argue that the challenges related to braille teaching are unlikely to be solved shortly, but increasing individuals' braille proficiency may be an alternative in the short term. Therefore, adequate systems and methods are needed to teach sighted individuals braille (Sasaki et al., 2007; Scheithauer & Tiger, 2012). At this point, using technology in braille teaching is considered one of the promising applications (Lee & Foo, 2010). The use of technology in teaching braille to sighted individuals brings advantages such as increasing interest in braille, facilitating learning and accessibility, and increasing the effectiveness of learning (Abd-Aziz et al., 2023). The ubiquitous accessibility of

teaching braille to sighted individuals is a solution that can overcome the shortage of qualified trainers (Putnam & Tiger, 2015).

It was determined that the research designs used in the reviewed studies were various. For example, while it is noteworthy that single-subject, qualitative, experimental, etc. research designs were used, some studies did not include direct information about the research design used. In the literature, similar results were obtained in the studies conducted as a literature review, and various research designs were used in the studies examined. For example, Aslan (2021), who performed a descriptive analysis of theses on braille, stated that various research designs were preferred in the relevant theses. In a study examining studies on the use of technology in special education (Kurt & Kurtoğlu-Erden, 2020), it was reported that various research models were used, and there were studies in which the research model was not specified. Similarly, Coşkunçay & Horzum (2022) stated that various research designs were used in their study to examine theses on individuals with visual impairments. In addition, researchers drew attention to the fact that some research designs were not used. Aslan & Özkubat (2019) emphasized that various research designs were used in the conference proceedings they examined and that there were studies without research model information. Another review study (Hoskin et al., 2024) explained that various research designs were used, such as case study, cohort design, and single-subject design. A similar situation is seen in the study conducted by Sözbilir et al. (2015). Based on these findings, it can be said that there is a similarity between the results obtained from this study and the results of the studies in literature. However, the limited number of studies reviewed in this study can be considered as a factor to be considered at the point of data interpretation. Although these findings indicate that the research designs used are various, the number of studies reviewed may require caution in generalizing the data. However, another important finding is that there were studies in which the research model was not reported. When these studies are examined, it is seen that they are generally studies that provide information about a subject or design or make a product or design. Studies support this finding in the literature (e.g., Aslan & Özkubat, 2019; Kurt & Kurtoğlu-Erden, 2020). Similarly, in these studies, it is seen that designs are not reported in studies such as design-based or systematic review studies.

When the related studies are examined, it is noteworthy that the researchers utilized various data collection tools such as braille translation/braille text reading, log recording, and oral reading fluency tests. Accordingly, the researchers used various data collection tools. In addition, it can be interpreted that the researchers diversified their data collection tools according to their research topics or the variables they examined. Similar to these findings, it is emphasized that various data collection tools are used in some systematic review studies (e.g., Coşkunçay & Horzum, 2022; Hoskin et al., 2024; Kurt & Kurtoğlu-Erden, 2020; Sözbilir et al., 2015). In this context, there is a similarity between the results obtained and the results of the studies in literature. More than one data collection tool was found in the reviewed studies. This situation may affect the relevant study's validity and reliability and contribute to its quality (Sözbilir & Kutu, 2008). The similarity in data collection techniques also manifests in the data analysis techniques.

In the studies reviewed within the scope of this research, various data analysis techniques were employed. It was determined that graphical analysis, descriptive statistics, and document analysis were used. In some studies, in the literature, content analysis and descriptive statistics are primarily used (e.g., Coşkunçay & Horzum, 2022; Sözbilir et al., 2015). The data analysis techniques used in the studies are thought to be related to the preferred research model. For example, it can be predicted that graphical analysis will generally be preferred in studies using a single-subject research design. The studies reviewed in this study determined that advanced analysis techniques (e.g., MANOVA, regression, structural equation) were not used. This situation may be related to research designs as well as the lack of experience of the researchers (Erdem, 2011). Therefore, it can be suggested that researchers should conduct new studies on braille teaching in which other (advanced) data analysis techniques will be used. At the same time, some studies did not provide any information about data analysis methods. In parallel with this finding, it was stated that data analysis information was not included in some studies (e.g., Coşkunçay &

Horzum, 2022; Sözbilir et al., 2015). When these studies are examined, it is seen that they generally address objectives such as system introduction or providing information. Therefore, the care should be taken to generalize these results. The limited number of studies on braille teaching causes the reviewed studies to be limited. Thus, the results obtained in this study may have resulted from the fact that studies on braille were examined.

Some studies included teachers, rehabilitation counselors, or parents as participants in the studies reviewed. In addition, it was found that these studies mainly involved undergraduate students (e.g., Putnam & Tiger, 2015; Scheithauer & Tiger, 2012; Scheithauer et al., 2013). In this respect, the situation obtained from the research is like the findings in the literature. For example, it is seen that some studies on the use of technology in braille instruction were conducted with undergraduate students (e.g., Koenig & Robinson, 2001; Lillie, 2017; Putnam, 2013; Putnam, 2015). It is thought that undergraduate students studied with the assumption that they are like teachers in terms of demographic characteristics. In addition, cost and convenience are also effective in reaching undergraduate students. The ease of collecting data from the participants in this group and the advantages in terms of the permission process, time, and cost can be considered as the reasons for preferring to work with this group (Alper & Gülbahar, 2009; Selçuk et al., 2014).

In addition to all this, this research has some limitations. First, the studies reviewed within the scope of the research were obtained from Web of Science, ERIC, Academic Search Ultimate, Google Scholar, and Scopus electronic databases. Secondly, the reviewed studies were found with keywords “braille,” “technology,” “sighted,” “computer,” “software,” and “teaching” and the word combinations “braille and technology,” “braille and sighted and technology,” “braille and computer,” “braille and software,” “braille and sighted,” “braille and teaching,” and “sighted and braille and teaching.” Thirdly, the studies reviewed consist of 10 studies published in a peer-reviewed journal, the full text of which can be downloaded, whose target audience is sighted individuals, and which address technologies/software/hardware related to Braille education. Lastly, the findings of this research were analyzed in the context of variables of a) purpose, b) research design, c) participants, d) data collection tool, e) data analysis, f) software/hardware, and g) findings.

CONCLUSION

As a result of the research, it was determined that the studies examined were mainly conducted to introduce software or provide information/examine existing software or resources and evaluate the effect of a computer-based program. In addition, the researchers revealed that mostly single-subject design studies were conducted. Almost all the participants in the studies were undergraduate students. In all these studies, researchers collected data by recording within the software, braille, and printed reading passages and analyzed them primarily through graphical analysis. Finally, it was revealed that there were more studies in which information about the software and the revisions made according to the test of the software were presented as qualitative findings.

RECOMMENDATIONS

It is noteworthy that various research designs, data collection tools, and analysis techniques were used in the study. However, more research is needed on braille teaching. Therefore, there is a need for experimental studies that can provide more evidence for further research. Studies on software that can run on different operating systems can be designed. In addition, researchers can develop new software on the subject and contribute to producing new research on this subject. In addition, further studies can be planned to include teachers and families as participant groups. Researchers working on the subject in future studies can apply data collection methods such as interviews and observations that are not used at all or rarely used, such as questionnaires and scales. Similarly, it may be suggested that studies be planned with research designs, especially mixed designs, which are never or are limitedly used. Finally, new studies can be conducted beyond the limitations mentioned in the limitations section of the study (e.g., searching

different databases, using different keywords, addressing these, etc.).

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