DESIGN, DEVELOPMENT, AND EVALUATION OF AN ONLINE LEARNING
MATERIAL TO SUPPORT THE READING COMPREHENSION
PERFORMANCE OF STUDENTS WITH LEARNING DIFFICULTIES IN AN
EXPOSITORY TEXT THROUGH TEACHING TECHNICAL VOCABULARY

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ABSTRACT

DESIGN, DEVELOPMENT, AND EVALUATION OF AN ONLINE LEARNING MATERIAL TO SUPPORT THE READING COMPREHENSION PERFORMANCE OF STUDENTS WITH LEARNING DIFFICULTIES IN AN EXPOSITORY TEXT THROUGH TEACHING TECHNICAL VOCABULARY

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The present study aimed to uncover the design principles of an online learning material designed to support the reading comprehension performance of students with learning disabilities in an expository text through teaching vocabulary. Moreover, it explored the effectiveness of the online learning material on students' reading comprehension and vocabulary test scores. The study employed design-based research with its three phases: analysis, design & development, and implementation & evaluation to seek answers to research questions in line with the purposes above. The study was initiated with the in-depth analysis phase by interviewing stakeholders to determine their needs and problems. Then a systematic literature review was performed to seek current technology use. Next, a draft material was prepared considering the findings in the analysis phase and evaluated with stakeholders through four iterative design cycles. Finally, the online learning material was tested with students with learning difficulties in the implementation & evaluation phase.

The participants were special education teachers, academics specialized in special education, and students with learning difficulties. The data were collected using semi-

structured interviews, observation notes, expert opinions, and achievement tests. The qualitative findings of the study revealed the principles for explicitly designing an online learning material for students with learning difficulties. Moreover, the quantitative findings uncovered that the online learning material positively affected students' reading comprehension and vocabulary performance. Overall, teachers, educators, and prospective researchers interested in learning difficulties may utilize the present findings. Yet, further research is needed to test the principles emerging in this study in different contexts.

Keywords: Special Education, Learning Difficulties, Online Learning Material, Use of Technology

ÖZ

ÖĞRENME GÜÇLÜĞÜ OLAN ÖĞRENCİLERİN BİLGİLENDİRİCİ BİR METNİ ANLAMASINA TEKNİK KELİMELERİN ÖĞRETİMİ YOLUYLA KATKI SAĞLAMAYI AMAÇLAYAN ÇEVRİM İÇİ ÖĞRENME MATERYALİNİN TASARIMI, GELİŞTİRİLMESİ VE DEĞERLENDİRİLMESİ

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Bu çalışmanın amacı öğrenme güçlüğü olan öğrencilerin bilgilendirici bir metni anlamalarına kelime öğretimi yoluyla katkı sağlamayı amaçlayan çevrim içi bir öğrenme materyalinin tasarım ilkelerini belirlemektir. Ayrıca, çalışma geliştirilen çevrim içi materyalin öğrencilerin okuduğunu anlama ve kelime performansları üzerindeki etkisini ölçmeyi de amaçlamaktadır. Çalışmanın amacını gerçekleştirmek için analiz, tasarım & geliştirme ve değerlendirme olmak üzere üç temel aşamadan oluşan tasarım tabanlı araştırma deseni kullanılmıştır. Çalışma ilk olarak detaylı bir analiz aşamasıyla başlamıştır. Analiz sürecinde paydaşlar ile görüşmeler yapılarak ihtiyaçlar ve sorunlar belirlenmeye çalışılmıştır. Ayrıca, öğrenme güçlüğü için teknoloji kullanımını belirlemeyi amaçlayan sistematik bir alan yazın taraması da yapılmıştır. Daha sonra analiz sürecindeki bulgular ışığında kâğıt üzerinde bir hikâye tahtası hazırlanmıştır. Tasarım & geliştirme aşamasında ise öğretmenler, akademisyenler ve öğrenme güçlüğü olan öğrenciler ile prototipi geliştirilen çevrim içi öğrenme materyalinin değerlendirilmesi dört aşamada yapılmıştır. Geliştirme sürecinin hemen ardından, nihai hale gelen çevrim içi öğrenme materyali öğrenme güçlüğü olan öğrenciler ile test edilmiştir.

Bu çalışmada öğrenme güçlüğü olan öğrenciler, özel eğitim öğretmenleri ve özel eğitim alanında akademisyenler katılımcı olarak yer almıştır. Katılımcılardan veriler yarı yapılandırılmış görüşmeler, gözlem, uzman görüşü ve başarı testleri ile toplanmıştır. Toplanan verilerin analizi ise nitel ve nicel analiz yöntemleri ile yapılmıştır. Çalışmanın nitel bulguları özellikle öğrenme güçlüğü olan öğrenciler için materyal tasarımında göz önünde bulundurulması gereken ilkeleri belirlemiştir. Çalışmanın nicel bulguları ise geliştirilen materyalin öğrencilerin okuduğunu anlama ve kelime testi sonuçlarını olumlu yönden etkilediğini ortaya koymuştur. Bunlara ek olarak, çalışmanın bulguları belirlenen tasarım ilkelerinin başka çalışmalar ile test edilmesi gerektiğini önermektedir.

Anahtar Kelimeler: Özel Eğitim, Öğrenme Güçlüğü, Çevrim içi Öğrenme Materyali, Teknoloji Kullanımı.

To the experiences that make me stronger

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ABBREVIATIONS

LD: Learning Difficulties

MLD: Mathematic Learning Difficulties

SET: Special Education Teachers

SEE: Special Education Experts

CHAPTER 1

INTRODUCTION

This chapter provides detailed information about the background of the study, the problem statement, the purpose and significance of the study, the research questions, the definitions of terms, and the chapter summary.

1.1 Background of the Study

The National Joint Committee on Learning Disabilities (NJCLD) (1991) defines Learning Difficulty (LD) as a disorder leading to difficulties in writing, reading, listening, and mathematical skills. Moreover, the Ministry of National Education (MoNE) (2010, 2013) identifies individuals with LD as those who need special education to handle their problems in writing, reading, speaking, spelling, and math. LD is known to be among the most prevalent disability types. According to the American Psychiatric Association (APA), 5% to 15 % of school-age children have specific learning difficulties (APA, 2013).

APA (2013) previously demonstrated three sub-categories for learning difficulties: *dyslexia* (reading-related problems), *dyscalculia* (math-related difficulties), and *dysgraphia* (writing-related problems). While defining LD, the MoNE (2010) also pointed out reading, writing, and math as the fields in which LD students have the most problems. Yet, there is no such further LD-oriented categorization in Turkey. The common practice is to diagnose children with "learning difficulties" without elaborating on their difficulties in any specific domains (Çakıroğlu, 2017).

Dyslexia is shown to be the most common LD according to APA (2013) and a worldwide-known type of LD (McBride, 2019). It is a life-long lasting disorder causing difficulties in written language (Hudson, 2016) and shows up with a significant deviation in one's intellectual potential and academic performance

(Wiznitzer & Scheffel, 2009). Dyslexia often causes problems in reading-related skills, such as comprehension, fluency, reading aloud, and accuracy (Hudson, 2016; Reid, 2007). Furthermore, dyslexia gives rise to struggles in understanding and summarizing a text, recognizing the gist, and event sequencing (Topbaş, 1998). However, its adverse effects can be alleviated thanks to appropriate and effective interventions (Hudson, 2016; Reid, 2007; Rief & Stern, 2010).

Reading, the most eminent domain where LD students suffer problems, consists of skills such as comprehension, spelling, decoding, and encoding (McCulley et al., 2013). Particularly, reading comprehension emerges as an essential skill significantly affecting one' academic and daily life (Elleman et al., 2009). Moreover, given that almost all courses in academic life rely on reading-related skills to different extents (Sarıpınar & Erden, 2010), reading comprehension becomes more critical since comprehending a written text is essential for learning (Westwood, 2016). Reading comprehension is known to be vulnerable to many factors. For example, lexical capaciticy seems to be among the prominent factors affecting comprehension (Duke et al., 2011; National Reading Panel (NRP), 2000). Previous research showed a significant relationship between reading comprehension and vocabulary (Furqon, 2013; Özata & Haznedar, 2018; Zhang & Anual, 2008). In contrast, limited lexical capacity was shown to adversely affect reading comprehension (Harris et al., 2011; Westwood, 2016). In this sense, it can be asserted that one may have more difficulty understanding a text as the number of unknown words in the text increases (Doğanay-Bilgi, 2017; Westwood, 2016).

Text type also needs to be considered for reading comprehension (Saenz & Fuchs, 2002). According to Gersten et al., (2001), expository texts are more complicated to understand compared to narrative texts probably because they contain more technical and unfamiliar vocabulary items (Gajria et al., 2007) and different text structures and subjects in which students have little experience (Kelley & Clausen-Grace, 2010). Understanding expository texts may particulaly be problematic for LD students (Bahap Kudret & Baydık, 2016; Saenz & Fuchs, 2002; Zimmerman & Reed, 2020) since they have already fallen behind their typically developing peers in terms of reading

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comprehension (Sarıpınar & Erden, 2010) and vocabulary (Delimehmet-Dada & Ergül, 2019). Thus, one should consider dictating unknown words for such students before reading the text to facilitate their reading comprehension and vocabulary acquisition (Kuşdemir, 2019; NRP, 2000). However, there may be insufficient time for vocabulary dictation in the classroom; therefore, vocabulary teaching should expand beyond school time (NRP, 2000). As Wright and Cervetti (2016) claimed, technology could grant the opportunity for vocabulary teaching in and out of school to support the reading comprehension of LD students (Carlisle et al., 2021; NRP, 2000).

Adopting technology in education has a significant potential to promote the teaching-learning processes in special education (Çağıltay et al., 2019). The relevant literature highlighted that technology could benefit students with difficulties as well as their typically developing peers (Butterworth & Laurillard, 2010; Drigas & Ioannidou, 2013; King-Sears & Evmenova, 2007). The technology could offer individualized and flexible learning environments thanks to specific (combined) software and devices (Massey, 2008). It could support students' learning both in and out of the classroom (Wagner et al., 2014) by providing learners with freedom and control over their learning processes (Jones et al., 2006) and the chance to practice more (Galatis & White, 2013; Kaur et al., 2017). Moreover, technology could allow students to study at their own pace and get immediate feedback on their work (Carter, 2005; Jitendra & Gajria, 2011). A plethora of studies indicated the positive impacts of technology on learning disabilities, particularly for reading comprehension (Cullen et al., 2014; Hall et al., 2015; Meyer & Bouck, 2014; Silver-Pacuilla, 2006; White & Robertson, 2015).

1.2 Statement of the Problem

McCulley et al., (2013) nominate reading as one of the critical areas in which LD students have problems. Reading consists of different skills, such as decoding, encoding, spelling, fluency, and reading comprehension (Westwood, 2016). Among them, reading comprehension, acquiring the meaning of a written text (Shanahan, 2005), emerges as one of the essential skills affecting students' learning (Westwood, 2016). As previously mentioned, some factors are likely to affect reading comprehension; for example, lexical capacity may be the most critical factor affecting

reading (Duke et al., 2011) since an inadequate lexical capacity may deteriorate students' reading comprehension performance (Westwood, 2004).

It becomes particularly prominent in the third and fourth grades (Delimehmet-Dada & Ergül, 2019) simply because science, social studies, and math overtly enjoy expository texts in these grades (Gersten et al., 2001). Thus, comprehension of expository texts becomes essential for students' achievement (Zimmerman & Reed, 2020). However, such texts sometimes become too complicated to understand because of unfamiliar content, technical vocabulary, and different text structures (Gersten et al., 2001; Kelley & Clausen-Grace, 2010).

Understanding expository texts could be more challenging for LD students (Bahap Kudret & Baydık, 2016; Saenz & Fuchs, 2002) because they have already have poor performance in reading comprehension (Cortiella & Horowitz, 2014; Sarıpınar & Erden, 2010) and vocabulary (Delimehmet-Dada & Ergül, 2019) compared to their TD peers. Unknown words could be dictated before reading a text to promote their comprehension performance (Kuşdemir, 2019; NRP, 2000; Wright & Cervetti, 2016). Nevertheless, teaching vocabulary may need to be extended beyond the classroom because school time may fail to cover all curricular activities (Kuşdemir, 2019; NRP, 2000).

In addition to understanding and vocabulary-learning problems, LD students may also have assistance in their overall learning processes. To begin with, LD students may need to practice newly-acquired knowledge more (Lawrence, 2009; Reid, 2007) with proper feedback (Vaughn et al., 2012) because having trouble processing and storing knowledge (Reid, 2005). Secondly, they may need extra time to study at their own pace while practicing with feedback (Vaughn et al., 2012). Third, LD students may have attention problems; thus, one-way presentation of information (e.g., teaching through only texts) could result in learning and knowledge-calling problems (Hudson, 2016). Therefore, information may need to be presented to such students in a way that addresses different senses to promote their learning (Reid, 2005). Lastly, students need flexible and individualized learning environments to meet their diverse needs (Brodin, 2010).

Given such students' learning needs and problems, it may be prudent to assert that there is a need for materials to allow them to practice what they have learned both in and out of school (Polat et al., 2012). Moreover, designing multisensory materials addressing different senses may further help them keep their attention and ease their memory in the learning process (Hudson, 2016; Reid, 2009). Furthermore, materials may need to be customized explicitly by considering their unique needs (Brodin, 2010; Çağıltay et al., 2019; Polat et al., 2012) to support their reading comprehension (Gajria et al., 2007).

1.3   Purpose of the Study

Ultimately, the present study aims to determine the design principles of an online learning material designed and developed to support LD students' reading comprehension of an expository text through teaching vocabulary. Moreover, it was attempted to investigate the efficiency of the online learning material on students' reading comprehension and vocabulary test scores.

1.4   Significance of the Study

The relevant literature consistently emphasized the significance of integrating technology into special education (Bouck et al., 2009; Chang et al., 2011; Drigas & Ioannidou, 2013), especially in promoting reading comprehension performance of LD students through teaching vocabulary (NRP, 2000; Wright & Cervetti, 2016). The previous findings illustrated that use of technology positively affects students' reading comprehension performance (Cullen et al., 2014; Ciullo et al., 2015; Floyd & Judge, 2012; Hall et al., 2015; White & Robertson, 2015). The mentioned studies often integrated public speech recognition and text-to-speech tools to promote the reading comprehension performance of LD students (Dogan & Delialioglu, 2020). Yet, it was also highlighted that the use of technology might not always result in positive outcomes. In other words, integrating technology into learning environments might not bring desired outcomes to meet the needs of students with disabilities (Drigas & Ioannidou, 2013; King-Sears & Evmenova, 2007). Thus, the technology may need to

be adapted and redesigned considering the needs of learners, teachers, and learning environments (Çağıltay et al., 2019; Gajria et al., 2007; Polat et al., 2012).

The current study contributes to the literature by designating design principles of the online learning material to promote LD students' reading comprehension in an expository text through teaching technical vocabulary. To accomplish the aim, the researcher conducted an inclusive analysis phase to determine the problems and needs of the LD students. Then, the researcher conducted four iterative design and development cycles with the stakeholders to get their opinions about the online learning material. The aim was to design and develop a learning material for LD students by considering their needs, characteristics, and problems. Thus, the study's contribution to literature is significant because it explicitly focuses on designing learning materials for LD students.

Sarıpınar and Erden (2010) complain about insufficient scholarly interest in learning and reading difficulties in our country, probably since designing appropriate interventions to support LD students seems challenging without scrutinizing their problems in reading comprehension and vocabulary learning. Similarly, Dogan and Delialioglu (2020) found in their review that limited studies investigated the effects of technology on students' reading comprehension performance through teaching vocabulary. In this regard, the present study is believed to contribute to the literature by developing material explicitly focusing on promoting students' reading comprehension performance through teaching vocabulary. Additionally, the study aimed to promote students' performance in an expository text covering more technical and unknown words, thus more challenging to understand. The significance studying how to promote reading comprehesion of LD students through teaching technical vocabulary shines bright considering the number of courses where students are exposed to expository texts in school.

Reid (2009) claimed that any materials oriented to LD students should be multisensory (Hudson, 2016), flexible, and individualized to meet their diverse needs (Brodin, 2010; Çağıltay et al., 2019) and allow students to practice in and out of the school with appropriate feedback (Polat et al., 2012). Given the above background, this research

aimed to develop an online, multisensory, individualized, and flexible learning material. Accordingly, the material would be multisensory since it would enrich targeted information with visuals, video/animation, and sound to appeal to multiple senses of LD students and make learning more effective. It would also allow students to work at their own pace independently and take all the necessary time needed, whether at home or school. Further, the material would allow customization by changing its font type and size and background color to be able to read it comfortably.

Apart from that, this study would be an example of Design-Based Research (DBR). It would generate a solution for a real-life learning problem by determining situation-specific design principles (Amiel & Reeves, 2008; Herrington et al., 2007). As required by DBR (Anderson & Shattuck, 2012; Plomp, 2013), the researcher worked with stakeholders collaboratively while settling on design principles to determine the needs of target beneficiaries from multiple viewpoints. Another significance of the study arises from presenting the method and findings sections straightforward to guide researchers, practitioners, and teachers interested in the use of technology for LD students.

To sum up, the current study is significant because of the following reasons. It aimed to design and develop an online learning material specifically for LD students by considering their needs. The desired to contribute to LD students' reading comprehension performance in an expository text by teaching vocabulary through the online learning material. Further, it proposed to develop a learning material that is online, multisensory, flexible, and individualized to promote students' learning. Last but not least, the study aimed to determine the principles for designing online learning material by working collaboratively with the stakeholders and presented a detailed result and method section to guide other researchers, practitioners, and teachers who want to research in this field.

1.5   Research Questions

The research questions that guide the current study are as follows:

1. What are the design principles for developing an online learning material to support the reading comprehension of LD students in an expository text through teaching technical vocabulary?
2. Does the developed online learning material affect the vocabulary scores of LD students?
3. Does the developed online learning material affect the reading comprehension scores of LD students?
4. What are the opinions of special education teachers and academicians about the materials and current use of technology to support the reading comprehension of LD students?

1.6   Definition of Terms

Special Education: Special education is a type of education that offers students with different disabilities the opportunity to engage in educational processes like students without disabilities (Vaughn & Linan-Thompson, 2003).

Learning Difficulty: The American Psychiatric Association (APA) (2013) defines LD as a disorder leading to problems in reading, writing, and math skills.

Dyslexia: Hudson (2016) describes dyslexia as a problem with the written language, resulting in difficulties in writing, reading, and spelling.

Dyscalculia: Price and Ansari (2013) identify dyscalculia as a disorder affecting the acquisition of arithmetical skills.

Dysgraphia: According to Nicolson and Fawcett (2011), dysgraphia is characterized by difficulties in writing.

CHAPTER 2

LITERATURE REVIEW

This section provides information on special education and Lerning Difficulty (LD), the prevalence and characteristics of LD, types of learning difficulties, and teaching strategies. Moreover, it presents a framework for the relationship between reading comprehension, vocabulary, and expository texts. Finally, the section uncovers the use of technology for LD students and relevant previous findings.

2.1 Special Education and Learning Difficulties

The 2018 data from the World Health Organization (WHO) reported that about 15% of people across the world had different disabilities (WHO, 2018). Similarly, the records of the Turkish Statistical Institute (TUIK) showed that 12.29% of the Turkey population had various disabilities (TUIK, 2002). Individuals with disabilities have different characteristics and unique needs; thus, they may need customized education (Sharma & Madhumita, 2012). At this point, *special education* offers disabled people the possibility of engaging in educational activities like their typically developing peers (Vaughn & Linan-Thompson, 2003). Ministry of National Education (MoNE) also describes special education as a field providing enhanced education programs, methods, and environments for students with disabilities (MoNE, 2010).

LD is one of the disability types that special education targets. According to the U.S. Department of Education (2016), it is the most common disability type for individuals aged 6-21 years. The American Psychiatric Association (APA) also shows that 5% to 15% of school-age children have learning difficulties across different cultures (APA, 2013).

The literature offers many definitions for *LD*. To begin with, Büttner and Hasselhorn (2011) describe LD as problems in specific cognitive developments and academic

accomplisshment without any other external reason. Moreover, National Joint Committee on Learning Disabilities (NJCLD) (1991) defines it as a disorder causing difficulty in listening, reading, writing, reasoning, and mathematical abilities. APA (2013) expounds *LD* as a disorder causing challenges in reading, writing, and mathematical skills. Furthermore, the Individuals with Disabilities Education Improvement Act (IDEA) (2004) designates LD as a disorder in the basic psychological and cognitive processes (e.g., speaking, writing, reading, spelling, and mathematical calculations). In addition, The Ministry of National Education (MoNE) (2010, 2013) identifies individuals with LD as those who need special education to handle their problems in writing, reading, speaking, spelling, and math.

LD, a life-long condition (Melekoğlu, 2017), emerges from neurological differences in brain functions. These differences affect one's ability to get, process, and retrieve information (Cortiella & Horowitz, 2014). Similarly, Rief and Stern (2010) claimed that LD is related to neurological problems in information processing (i.e., acquiring, sequencing, organizing, remembering, and expressing knowledge). Moreover, LD does not emerge because of other disability types, such as visual, hearing, and mental disabilities (Cortiella & Horowitz, 2014; IDEA, 2004). Despite occurring concurrently with other disabilities or external influences (e.g., cultural alterations and inadequate instruction), LD is not totally associated with them (NJCLD, 1991). In addition, learning difficulties manifest themselves as unexpectedly poor performance of an intelligent or talented student in a standardized test (APA, 2013; Büttner & Hasselhorn, 2011). According to Wiznitzer and Scheffel (2009), individuals with LD have average or more intellectual potential. However, there may be significant differences between their potential and actual performance in reading, writing, and math.

LD students are likely to experience problems with reading, spelling, organizing, and recalling knowledge (LD Online, 2022). Moreover, they have difficulty understanding what they read, organizing paragraphs, punctuation, acquiring number sense, facts, and mathematical reasoning (APA, 2013). Furthermore, they have trouble dividing words into syllables and letters and pronouncing the sounds of some letters correctly. Also, they struggle to follow the sequence of events and understand abstract concepts

(MoNE, 2010; MoNE, 2013). Comprehending a text, telling a story, and expressing the days of the week and months in order are also among the difficulties such students often experience. Besides, they have weaknesses in time- and direction-oriented concepts MoNE (2013) with short attention time and little motivation for reading (Lawrence, 2009).

2.2 Types of Learning Difficulties

According to the National Association of Special Education Teachers (NASET, 2005), learning difficulties may generate significant problems in reading, written language, and math. It should be noted that learning difficulties may appear in diverse forms. In this sense, APA (2013) points out three main types of learning difficulties: dyslexia, dysgraphia, and dyscalculia. Although MoNE (2010) emphasizes difficulties in reading, writing, and math while defining LD, it does not attempt to offer further categorization (Çakıroğlu, 2017). Since different types of LD bring different impacts on one's life (American Psychiatric Association, 2013), the types of LD are explained in detail below.

2.2.1 Dyslexia

The term *dyslexia* comes from "dys- difficult" and "lexis- words," which means difficulty with words (Hudson, 2016; Massey, 2008). According to Rief and Stern (2010), dyslexia is the most prevalent type of learning difficulty (APA, 2013; Cortiella & Horowitz, 2014). Similarly, McBride (2019) claimed that dyslexia is a worldwide recognized learning difficulty. Contemporarily, about 80% of all children recognized as LD have dyslexia (Wiznitzer & Scheffel, 2009).

Wiznitzer and Scheffel (2009) define *dyslexia* as a significant discrepancy between one's performance in reading and intellectual potential. Moreover, Hudson (2016) identifies it as a problem with the written language. Furthermore, APA (2013) describes dyslexia as an impairment in reading-related problems such as reading accuracy, reading rate, reading fluency, and reading comprehension. Despite a plethora of definitions for dyslexia (Reid, 2007), the literature has never come to a consensus on its definition (Lawrence, 2009; Mortimore, 2008; Reid, 2009; Westwood, 2004).

However, dyslexia is mainly characterized by being a life-long condition (Hudson, 2016; Rief & Stern, 2010) and literacy-related problems (Reid, 2007). Rief and Stern (2010) explained that although dyslexia is a life-long situation, appropriate interventions could alleviate dyslexia-specific problems (Hudson, 2016). Likewise, Reid (2007) defines *dyslexia* as a life-long disorder that can be supported with effective interventions to overcome its adverse effects.

According to Rief and Stern (2010), dyslexia does not occur because of environmental factors, poor educational opportunities, hearing or visual problems, and lack of motivation (Hultquist, 2006). Similarly, it does not arise because of an accident or illness (Hudson, 2016). Dyslexic children do not have any intellectual impairment (Hultquist, 2006), even enjoying the potential to learn like their typically developing peers. However, they learn differently, and some tasks may be more challenging for them (Reid, 2005).

Dyslexia causes short-term memory weaknesses and slow information processing (Lawrence, 2009). Moreover, it results in problems with concentration, organization, and fatigue (Hudson, 2016). Furthermore, dyslexia give rise to challenges with self-esteem, motivation, and concentration (Massey, 2008). It also engenders problems in following complicated verbal directions, learning a foreign language, and remembering right and left (Hultquist, 2006). Besides, dyslexia cause struggles in sequencing letters, numbers, and days of the week in the correct order (Massey, 2008; Reid, 2005). In addition, Cortiella and Horowitz (2014) defines general characteristics of dyslexia as *difficulty* with phonemic awareness, phonological process, fluency, decoding, spelling, reading rate, vocabulary, written expression, rhyming, and comprehension.

Hudson (2016) defines *dyslexia* as problems with the written language, resulting in difficulties in writing, reading, and spelling. To begin with, it causes reading-related problems (e.g., reading comprehension, reading accuracy, reading aloud, reading fluency, and expressive writing) (Massey, 2008; Reid, 2007). Furthermore, dyslexia raises difficulties in reading and understanding texts, finding the gist of the text, ordering events, defining characters, and summarizing texts (Topbaş, 1998). Secondly,

dyslexia could result in writing-related problems (e.g., slow writing, poor quality in punctuation and spelling, capitalization errors, and poor organization of thoughts) (Hudson, 2016). Finally, dyslexia gives rise to problems in word recognition, spelling, and decoding – the components of the phonetic part of the language (Lyon et al., 2003; Rief & Stern, 2010; Shaywitz & Shaywitz, 2005). Furthermore, it can bring about inconsistent spelling, missing out syllables, confusing consonant letters, and misspelling names of places and people (Hudson, 2016).

Despite its shortcomings, dyslexia may also be characterized by some strengths. According to Hudson (2016), some of the strengths of dyslexic students may be imaginative and innovative thinking, perfect visualization, and outstanding performance in arts. Moreover, a good sense of texture and color, intuitional problem-solving, and high empathy and emotional intelligence may also be counted among the strengths of dyslexic individuals.

2.2.2 Dyscalculia

Math is a significant and complex subject Butterworth (2003) and comprises arithmetic problem-solving, algebra, geometry, statistics, and calculus. Moreover, it needs number sense, memory, logic, decoding of symbols, and visual-spatial capacity. Insufficiencies in these mathematical skills are defined as mathematical learning difficulties (MLD) or *Dyscalculia* (Karagiannakis et al., 2014). The term dyscalculia comes from the words "dys-difficulty" and "calculate-calculus," which refers to "difficulty in counting" (Massey, 2008, p. 82).

Dyscalculia is a disorder affecting the acquisition of arithmetical skills   (Price & Ansari, 2013). Similarly, Butterworth (2003) calls dyscalculia number blindness affecting one's ability to get arithmetical skills (Butterworth, 2005). Dyscalculia manifests itself as a significant deviation between one's academic performance in math and intellectual potential (Wiznitzer & Scheffel, 2009).

According to Massey (2008), *dyscalculia* can occur independently and with other learning difficulties, such as dyslexia. Wiznitzer and Scheffel (2009) asserted that children with dyscalculia have average or above-average intellectual potential, but

their mathematical achievements fall behind their intellectual potential. Dyscalculia is not extensively recognized, like dyslexia. There is confusion about dyscalculia, as dyslexia had once (Butterworth, 2005).

Butterworth (2005) proposed that the typical manifestation of dyscalculia is problems with basic arithmetical skills. It ends up with low performance even in simple mathematical tasks (e.g., comparing numbers and counting in the correct order) (Cortiella & Horowitz, 2014). Moreover, according to APA (2013) dyscalculia causes problems in learning, grasping arithmetic facts and number sense, and doing mathematical calculations and reasoning. Yet, such skills seem essential for satisfying one's needs in daily life. For example, numbers sense may be crucial in dealing with simple, everyday tasks, such as counting, understanding simple statistical information, and reading the clock (Fischer et al., 2013).

Additionally, Hudson (2016) argued that dyscalculia makes it challenging to grasp numbers, round numbers, and remember facts and mathematical procedures. Also, it results in problems with mental arithmetic, confusing numbers, and comprehension of the written question. Last but not least, dyscalculia may ruin one's problem-solving, number quantities, measurement, telling time, and counting skills (Cortiella & Horowitz, 2014).

2.2.3 Dysgraphia

Dysgraphia is a disorder related to writing skills (NASET, 2005). The term dysgraphia is derived from the words "dys-difficulty" and "graphia – writing," which corresponds to "difficulty with handwriting" (Hudson, 2016). McBride (2019) identifies dysgraphia as problems with spelling and writing. Moreover, Wiznitzer and Scheffel (2009) define *dysgraphia* as a significant deviation of one's performance in writing from their intellectual potential. Hultquist (2006) also designates it as messy handwriting and problems in the physical act of writing (Cortiella & Horowitz, 2014). Similarly, Hudson (2016) describes dysgraphia as physical problems with scripting. According to Nicolson and Fawcett (2011), dysgraphia is characterized by difficulties in writing. Dysgraphia manifests itself as illegible and poor handwriting (Simner &

Eidlitz, 2000). In addition, according to Hudson (2016), dysgraphia is a learning difficulty affecting one's handwriting and putting thoughts into words.

Dysgraphia emerges in three forms: spatial, motor and processing. Spatial dysgraphia results in difficulties in spacing letters and writing on lines. The second form is related to controlling of wrist muscles and hand, namely the physical part of writing. The last one, processing dysgraphia, also known as dyslexic dysgraphia, is about failing to visualize the letters in words (Hudson, 2016).

According to Hudson (2016), individuals with dysgraphia have problems spacing between letters and words, writing on a line, following margins, drawing, organizing words, and forming letters in terms of size and shape. The report of Cortiella and Horowitz (NJCLD, 2014) also revealed that such individuals struggle with spacing between words/letters, creating shapes of the letters, and writing within margins or in a line.

Hultquist (2006) explained that dysgraphia distorts the physical act of writing (motor dysgraphia), such as holding a pencil correctly, drawing a line, and writing legibly. Likewise, dysgraphia results in abnormal hand position and grasping of the pen, illegible handwriting, slow writing, and unusual body and wrist position (Hudson, 2016). Moreover, it causes problems related to body position, pencil grabbing, and getting tired quickly (Cortiella & Horowitz, 2014).

Individuals with dysgraphia struggle with spelling, organization of written statements, grammar, and punctuation issues (APA, 2013; Hudson, 2016). Moreover, they have difficulties organizing text structure, attention to cohesion and cohesiveness, and having a large vocabulary (Topbaş, 1998). Furthermore, individuals with dysgraphia reverse letters and numbers and skip/add syllables while writing a text (e.g., b instead of d or 12 instead of 21). Also, they have difficulty dividing a word into syllables (MoNE, 2010), organizing their thoughts on a paper, following thoughts in a written text, and expressing their understanding of a text (Cortiella & Horowitz, 2014).

2.3   Dyslexia and Reading Comprehension

Reading and writing are fundamental skills for a child starting school. As such, reading occupies a prominent place in primary school curricula since nearly all courses rely on reading skills (Sarıpınar & Erden, 2010). It involves many subskills, such as decoding, encoding, spelling, and comprehension. Reading comprehension may be the primary outcome of reading because understanding what is read is essential for learning (Westwood, 2016). Lane (2014) also emphasized that understanding a text is the goal of reading. Yet, McCulley et al., (2013) showed reading as the area in which most students with learning disabilities have problems. Thus, difficulties in reading comprehension adversely affect one's life (Elleman et al., 2009; Sarıpınar & Erden, 2010).

Reading comprehension is a process of extracting and constructing meaning interactively and simultaneously from a written text (Shanahan et al., 2010). Likewise, it is the act of interpreting and understanding the knowledge placed in a text (Shanahan, 2005). McCulley et al., (2013) asserted that deriving meaning from a text or comprehension calls for a series of cognitive processes: knowing how to read words, attempting to define words, and bringing adequate prior knowledge about words to the text. Moreover, Shanahan (2005) explained factors influencing reading comprehension as "phonemic awareness, phonic, oral reading fluency, and vocabulary" (p. 31). Graham and Bellert (2004) explained that reading comprehension problems could originate from difficulties in background knowledge, fluency, lexical capacity, and word recognition/decoding.

2.4   Reading Comprehension and Vocabulary

National Reading Panel (NRP) (2000) designates reading comprehension as a cognitive process integrating complex skills. It cannot be fully understood without considering the role of vocabulary. Building vocabulary is one of the fundamental elements of efficient reading comprehension (Duke et al., 2011). According to Hirsch (2003), the breadth of vocabulary boosts reading comprehension (NRP, 2000) and promotes learning.

Vocabulary is a prerequisite for reading and comprehension (Kuşdemir, 2019). Taşdemir and Özmen (2018) stated that some strategies may be adopted before, during, and after reading to uncover the meanings of the words. Searching for the meaning of unknown words is one of the steps in these strategies. In their study, Verhoven and Leeuwe (2008) found that vocabulary strongly influences reading comprehension. Moreover, Doğanay-Bilgi (2017) discovered a significant relationship between vocabulary and reading comprehension. In this regard, an increased number of unknown words in a text may result in an extended mental effort to understand the sentences, including the unknown words and the text. Furthermore, Joshi (2005) argued that vocabulary and reading comprehension have a close relationship where inadequate lexical capacity results in difficulties comprehending a written text. Hirsch (2003) and Joshi (2005) also justified the relationship between reading comprehension and vocabulary knowledge.

Additionally, Quinn et al., (2015) emphasized that vocabulary knowledge influences reading comprehension; therefore, deficits in vocabulary knowledge adversely affect students' reading comprehension (Harris et al., 2011; Westwood, 2004). Likewise, Westwood (2016) expressed that a limited lexical capacity negatively influences reading comprehension. As a rule of thumb, there should be a match between one's vocabulary knowledge and the words used in the text; otherwise, one may have comprehension difficulties. In addition, Wright and Cervetti (2016) found in their review that teaching the meanings of the unknown words in a passage support reading comprehension.

2.5   Reading Comprehension and Vocabulary in Expository Texts

Vocabulary is one of the essential factors affecting reading comprehension. The previous research extensively sought vocabulary-reading comprehension relationship and concluded a significant link between them (Babayiğit & Stainthorp, 2013; Furqon, 2013; Özata & Haznedar, 2018; Verhoven & Leeuwe, 2008; Zhang & Anual, 2008). Moreover, a moderately significant relationship was previously reported between vocabulary and comprehension of narrative texts (Bahap Kudret & Baydık, 2016; Delimehmet-Dada & Ergül, 2019; Yıldırım et al., 2011). Furthermore, some other

studies documented robust (Yıldırım et al., 2011) and moderate significant relationships between vocabulary and comprehension of expository texts (Delimehmet-Dada & Ergül, 2019).

The text type is also essential for reading and reading comprehension (Saenz & Fuchs, 2002; Temizyürek, 2008). Gersten et al., (2001) argued that expository texts may be hard to comprehend when compared with narrative texts (Temizyürek, 2008) since containing technical words/concepts (Dymock & Nicholson, 2010). Moreover, expository texts may appear in different text structures (e.g., definitive, comparison, and cause-effect) (Gersten et al., 2001). Also, they may consist of topics that students have never experienced before (Kelley & Clausen-Grace, 2010). In addition, extracting meaning from expository texts needs more complex cognitive tasks because they differ in structure, difficulty level, and vocabulary (Gajria et al., 2007; Roehling et al., 2017).

Yet, Zimmerman and Reed (2020) explained that comprehending expository texts may be key to academic achievement. Since LD students have already had reading comprehension problems (Sarıpınar & Erden, 2010) and poor vocabulary knowledge when compared with their TD peers (Delimehmet-Dada & Ergül, 2019), understanding expository texts may be more challenging for them (Gajria et al., 2007); Zimmerman & Reed, 2020). Previous research also confirmed that understanding expository texts may be more complex than narrative texts for LD students (Bahap Kudret & Baydık, 2016; Saenz & Fuchs, 2002).

Harris et al., (2011) highlighted various categorizations for vocabulary instruction. However, in a broader sense, it can be categorized as generative and non-generative. Instruction in generative approaches focuses on teaching a word, which refers to that students must deploy their knowledge of that word to figure out the meanings of the other related words (Harris et al., 2011; McCulley et al., 2013). On the other hand, the non-generative approach focuses on teaching a word in isolation. The aim is to teach only the word's meaning. However, students are not expected to use that word to unlock the meaning of the other related words (Harris et al., 2011; McCulley et al., 2013).

Words belonging to a discipline-specific area, such as science, math, and social studies, can be taught through non-generative approaches (McCulley et al., 2013). The expository texts students recite in such disciplines at the school may also include hard-to-understand technical words (Gersten et al., 2001). Thus, teaching the meaning of an unknown word before reading can boost students' reading comprehension and vocabulary acquisition (Kuşdemir, 2019; NRP, 2000).

The NRP (2000) suggested that teaching estimated vocabulary size may not match in-classroom time; hence, vocabulary instruction should expand beyond the classroom. Kuşdemir (2019) also stated that vocabulary teaching inevitably requires extra time and effort. In this sense, technology may be deployed to facilitate teaching unknown words in a text (Wright & Cervetti, 2016). As a matter of fact, vocabulary teaching through technology positively impacts learning compared to traditional methods (NRP, 2000), which is grounded on two major opportunities by technology. Firstly, it could be utilized to allow students to practice in and out of the classroom. Secondly, it could bring different modalities to the learning environment thanks to media integration (NRP, 2000).

2.6 Teaching Strategies for Students with Dyslexia

Dyslexia is not a curable disorder and follows a life-long course. However, it is well-known that effective interventions can reduce its adverse effects (Reid, 2007). Since students with dyslexia have attention and short-term memory problems (Lawrence, 2009), they may have difficulty remembering and acquiring knowledge presented through a single channel (Hudson, 2016). Therefore, multisensory intervention strategies may need to be used to overcome such difficulties (Hudson, 2016; Reid, 2009). Multisensory teaching addresses different senses of students (e.g., visual, kinesthetic, and auditory) and aims to keep attention, ease memory, and provide engagement in learning processes (Westwood, 2016). Furthermore, multisensory teaching facilitates the retention of information in memory (Hudson, 2016; Massey, 2008). Thus, instructional materials should address students' different senses (Özmen, 2017; Reid, 2007). Besides, multisensory learning may occur through multimedia and computer-based learning programs that are famous for audio-visual programs;

therefore, students may catch a chance to listen, look, respond to, and participate actively in the learning process (Westwood, 2016). Using visuals especially helps students learn and concretize verbal information (Doğanay-Bilgi, 2017).

Secondly, providing verbal information and instruction in chunks is essential for dyslexic students. Dyslexia is often characterized by slow information processing and short-term memory weaknesses (Lawrence, 2009). Similarly, Reid (2005) explained that since affecting short-term and working memory, dyslexia limits the amount of information stored in the memory. Reid (2007) and Massey (2008) also claimed that children with dyslexia have difficulty remembering and following long instructions. Thus, the instructions for such students may be restructured as short and clear and provided one at a time (Özmen, 2017; Reid, 2005).

Lastly, children with dyslexia need to reinforce their newly learned knowledge to transfer it from short-term memory to long-term memory (Reid, 2007). For this, they may need several repetitions and lots of practice (Lawrence, 2009; Reid, 2007). Moreover, students need time to proceed at their own pace (Reid, 2005) and immediate feedback to correct inaccurate practices (Vaughn et al., 2012). Feedback is essential because it contributes to students' motivation (Özmen, 2017). Also, immediate feedback and practice are essential instructional elements to help students to keep knowledge in the long run (Çağıltay et al., 2019).

2.7   Technology and Learning Difficulties

Students with disabilities may have unique characteristics and needs (Brodin, 2010; Sharma & Madhumita, 2012). At this point, special education addresses their needs and characteristics and needs to reduce or eliminate their problems (MoNE, 2010; MoNE, 2013; Vaughn & Linan-Thompson, 2003). Yet, it should be noted that special education may have to provide individualized and flexible learning environments to meet the diverse needs of these students to promote learning (Brodin, 2010). Although it has always been a challenge to overcome, technology could be one way to handle this situation (Massey, 2008; Ray & Atwill, 2004).

Çağıltay et al., (2019) argued in their study that technology has a significant potential to facilitate teaching-learning processes in special education. Moreover, Florian (2004) proposed that using technology could help create conditions to support equality of opportunity in education through materials addressing specific needs. Furthermore, Hudson (2016) claimed that technology could significantly contribute to students' academic achievement.

Butterworth and Laurillard (2010) asserted that technology could give a chance to design digital interventions to offer students more practice (Massey, 2008; Zhang, 2000). Similarly, Kaur et al., (2017) found that technology contributes to learning through opportunities to practice and recitation. In this regard, practice can be claimed to be an important instruction element (Çağıltay et al., 2019), helping transfer knowledge into long-term memory (Lawrence, 2009; Reid, 2007). Moreover, the use of technology allows students to get immediate, supervision-free feedback (Carter, 2005; Jitendra & Gajria, 2011; Mohammed & Kanpolat, 2010). Immediate feedback is particularly valuable since preventing inaccurate practices (Vaughn et al., 2012) and motivates students (Özmen, 2017). Furthermore, technology provides students with the chance to work independently at their own pace (Carter, 2005; Jitendra & Gajria, 2011) and control their learning process (Jones et al., 2006).

Besides, using technology could help create individualized and flexible learning environments (Galatis & White, 2013), which are essential to meet students' diverse needs (Brodin, 2010). Likewise, Cortiella and Horowitz (2014) claimed that technology could provide students with individualized and personalized instructions. In other words, it gives a chance to create learning materials considering various individual differences (Traxler, 2009) and the unique needs of different disability types (Galatis & White, 2013). Moreover, technology removes time and space boundaries in the learning process (Hashemi et al., 2011) by supporting learning and practice both in and out of the school settings (Cortiella & Horowitz, 2014; Wagner et al., 2014).

Additionally, technology provides a chance to design multisensory learning environments (Massey, 2008) to address multiple through various media (e.g., visuals, videos, and audio) (Reid, 2007). Combining different media with verbal or written

materials is then likely to facilitate learning (Fletcher & Tobias, 2005) and result in better reading comprehension. Likewise, Hudson (2016) and Massey (2008) argued that multisensory learning environments facilitate knowledge retention. Since it makes learning more attractive (Fletcher & Tobias, 2005), it helps students to keep their attention on learning (Westwood, 2016). In addition, technology could promote students' understanding by directing their attention to the focus of instruction in the learning process (Mayer, 2005c; Moreno, 2007) through relevant cues (Mautone & Mayer, 2001; Mayer, 2017; Westwood, 2016).

Çoklar, Ergenekon, and Odabaşı (2018) addressed technology within three categories: assistive (AT), instructional, and socializing assistive technologies. AT aims to increase the functionality, independence, and competency of students with special needs. Moreover, it intends to eliminate students' problems by supporting needs-intense areas (WHO, 2012); therefore, it serves as instructional technology (Çoklar et al., 2018). WHO (2012) considers AT an umbrella term and proposes that it includes many technologies such as wheelchairs, visual and hearing aids, and computer software. IDEA (2004) defines AT as "any item, piece of equipment, or product system, whether acquired commercially off the shelf modified, or customized that is used to increase, maintain, or improve functional capabilities of a child with a disability" (p. 6).

Since contemporary educational activities enjoy technology, special education does not fall behind the advancements in technology and seeks full benefit from it. King-Sears and Evmenova (2007) explained that technology could promote the learning processes of students with and without disabilities (Butterworth & Laurillard, 2010; Drigas & Ioannidou, 2013). The relevant literature hosts many studies highlighting the importance of the use of technology in special education (Blackhurst, 2005; Bouck et al., 2009; Chang et al., 2011; Drigas & Ioannidou, 2013; Hetzroni & Tannous, 2004; Lin et al., 2008) and attempting to determine the impacts of technology on special education, particularly for LD students (Corkett & Benevides, 2016; Keyes et al., 2016; Nelson & Reynolds, 2015; Polat et al., 2019; Satsangi & Bouck, 2015; Satsangi

et al., 2016; Shin & Bryant, 2017; Skiada et al., 2014; Stetter & Hughes, 2011; Stultz, 2013; Tariq & Latif, 2016; Xin et al., 2017).

2.7.1 Previous Research on the Use of Technology for LD

LD is one of the most widespread disability types worldwide (U.S. Department of Education, 2016). According to APA (2013), LD is a disorder resulting in difficulties in reading, writing, and math. The MoNE (2010) also defines it as difficulties related to reading, writing, and math (MoNE, 2013). This section touches upon the previous research seeking the effects of technology on LD students' reading, writing, and mathematical skills.

2.7.1.1 Previous Research Seeking the Effects of Technology

Reading-Related Skills

Reading is one of the areas in which LD students have problems. Previous studies showed that using technology can boost reading-related skills (e.g., reading comprehension, reading fluency, reading rate, reading aloud, oral presentation, and acquisition of sight words) among LD students.

Hall et al., (2015), Twyman and Tindal (2006), Xin and Rieth (2001), and Higgins and Raskind (2000) found in their studies that technology has significant effects on LD students' reading comprehension skills. Moreover, it was revealed that the use of technology positively affects students' reading comprehension (Ciullo et al., 2015; Cullen et al., 2014; Floyd & Judge, 2012; Wade et al., 2010; White & Robertson, 2015).

Keyes et al., (2016), Decker and Buggey (2014), and Papadima-Sophocleous and Charalambous (2014) sought the impacts of technology on reading fluency. Their findings consistently showed an improvement in students' reading fluency levels thanks to the use of technology in learning. Moreover, a study by White and Robertson (2015) concluded a significant effect of technology on students' reading fluency.

Kennedy et al. (2015) and Kennedy et al., (2014) investigated the effects of technology on LD students' vocabulary knowledge. As a result, they concluded the significant

effects of technology on vocabulary knowledge. Moreover, Lange et al., (2009) and Silver-Pacuilla (2006) investigated the effects of technology on LD students' literacy skills. While the results of the former study revealed significant improvements, the latter did not conclude any significant results.

Last but not least, the studies of Dolan et al., (2005), Klemes et al., (2006), Cullen et al., (2013), and Scheeler et al., (2010) demonstrated positive effects of technology on LD students' reading aloud, reading rate, acquisition of sight words, and oral presentation skills, respectively.

Writing-Related Skills

Writing is the other area in which most LD students have problems. As in the previous part, it was found that many studies previously investigated the effects of technology on LD students' writing-related skills (e.g., planning and writing a persuasive essay, written expression, authoring, narrative writing, note-taking, and dictation).

Evmenova et al., (2016) and Hetzroni and Shrieber (2004) investigated the effects of technology on students' planning and writing persuasive essay skills. Their results showed the positive effects of technology on students' writing performance. Moreover, Englert et al., (2005) reported significant improvements in students' essay performance thanks to technology.

Some other studies sought the effects of technology on students' written expression skills. In these studies, authors found that the use of technology positively affects students' written expression performance (Corkett & Benevides, 2016; Higgins & Raskind, 1995; Williams, 2002). Furthermore, Dimitriadi (2001) and Zhang, (2000) investigated the effects of technology on students' authoring skills and suggested technology brings positive impacts on students' authoring performance.

In addition, the literature hosts studies investigating the effects of technology on students' narrative writing, dictation, and fundamental writing skills (Nelson & Reynolds, 2015; Silió & Barbetta, 2010; Tariq & Latif, 2016). Overall, the previous findings pointed out the positive effects of the use of technology on the mentioned

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skills. Lastly, Belson et al., (2013) revealed in their study that the use of technology brings significant impacts on students' note-taking skills.

Math-Related Skills

Math is another discipline where most LD students have problems. In the literature, one may encounter a plethora of studies examining the effects of technology on students' math-related skills (e.g., multiplication, subtraction, word problem-solving, mathematical reasoning, problem-solving, number combination, and area and perimeter calculation).

Shin and Bryant (2017), Seo and Bryant, (2012), and Seo and Woo, (2010) examined the effects of the use of technology on word problem-solving skills. Their results indicated positive impacts of the use of technology on students' word problem-solving skills. Some other studies concluded that technology-assisted teaching boosts students' multiplication and subtraction performance (Bryant et al., 2015; Irish, 2002; Nordness et al., 2011).

Moreover, previous research seeking the relationship between technology and problem-solving skills (Skiada et al., 2014; Xin et al., 2017) concluded that technology promotes students' problem-solving performance. Moreover, Huscroft-D'Angelo et al., (2014) noted improvements in students' mathematical reasoning skills. Likewise, Fuchs et al., (2006) found that technology positively impacts students' number combination skills.

2.8   Design Issues in Instructional Technology

Seels and Richey (1994) defined Instructional Design (ID) as "the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (p.1). It is a system of procedures to develop educational material in a reliable and consistent fashion (Branch, 2018). Moreover, ID is a discipline mainly concerning prescribing optimal methods of instruction to result in desired changes in the knowledge and skills of students for a specific content (Reigeluth, 1983).

According to Gustafson and Branch (2002), there are many systematic instructional design models. They include "analysis, design, development, implementation, and evaluation (ADDIE)" which are the key elements for ensuring consistency between "goals, strategies, and evaluation and the effectiveness of the instruction" (p.18). The instructional design models have iterative and self-correcting nature since it is often necessary to move forth and back among the steps and make necessary revisions. Thus, it means that the steps of ADDIE are not completely linear (Branch, 2018). The below part presents detailed information about the steps and how they are ensured in the current study.

Firstly, the a*nalysis* aims to conduct a need assessment (Rosset, 1993), determine a performance problem in an environment (Gilbert, 1978), and set a goal (Mager, 1984). In the current study, a systematic literature review and semi-structured interviews were conducted to determine needs and problems. Secondly, the d*esign* aims to determine learning objectives (Dick et al., 2015) and specify media and learning activities. In the design step, a storyboard of the online learning material was developed on paper. The storyboard described how the activities and media, such as visuals, audio, and video will be like. Thirdly, the d*evelopment* includes preparing the instructional material determined during the design step (Morrison et al., 2004). In the current study, the online learning material was developed based on the storyboard by taking the expert opinions from academicians, special education teachers, and students with LD through four iterative phases.

Fourthly, the i*mplementation* step focuses on delivering the developed material into the setting which the material is designed for (Greer, 1996). The developed online learning material was implemented in a real-life learning environment. The researcher worked with students with LD in a special education and rehabilitation center. Lastly, the e*valuation* consists of both formative and summative evaluations by conducting necessary revisions. The aim of formative evaluation is to collect data about necessary revisions for the instruction. The summative evaluation on the other hand aims to collect data to assess the effectiveness of the overall instruction (Branch, 2018; Gustafson & Branch, 2002). A formative evaluation was carried out in the design and

development phase of the current study. The experts examined the online learning material and provided recommendations through four iterative cycles. The revisions were applied to the material. On the other hand, summative evaluation was performed in the evaluation phase of the study. The effectiveness of the online learning material was investigated through a single-group pretest-posttest design.

2.9   Chapter Summary

Across the world, about 15% of people suffer from different disabilities (WHO, 2018). It is known that individuals with disabilities have unique characteristics and needs; thus, they are likely to need special education. (Sharma & Madhumita, 2012). *Special education* deals with the education of individuals with disabilities (MoNE, 2013), appearing in several forms, such as LD.

LD is a widespread disability in school-age children (U.S. Department of Education, 2016). IDEA (2004) defines LD as a disorder causing problems in reading, writing, and math skills (APA, 2013). LD does not occur because of any other disability type or external influence, such as inadequate instruction or cultural alterations (Disabilities, 1991). According to Cortiella and Horowitz (2014), it originates from neurological differences in brain structure and function. Such differences then influence individuals' ability to get, process, and retrieve information. LD primarily occurs as dyslexia, dyscalculia, and dysgraphia (APA, 2013).

Firstly, *dyslexia* refer to having difficulties with words and results in problems with reading, writing, and spelling (Hudson, 2016). *Dyscalculia* corresponds to difficulty in counting (Massey, 2008) and is considered a disorder influencing the acquisition of arithmetical skills (Butterworth, 2005). It is indeed an unexpected gap between one's mathematical performance and intellectual potential (Wiznitzer & Scheffel, 2009). Lastly, *dysgraphia* is the other disability type resulting in messy handwriting and yields problems with the physical act of writing, such as abnormal hand position and unusual body and wrist position (Hudson, 2016).

Dyslexia is the worldwide known type of LD (McBride, 2019); nearly 80% of children are diagnosed with dyslexia annually (Wiznitzer & Scheffel, 2009). According to APA

(2013), it is an impairment causing reading-related problems such as accuracy, fluency, reading rate, and reading comprehension. Also, Hudson (2016) identifies dyslexia problems with the written language, such as spelling, writing, and reading. Despite being considerably defined in the literature, it is a life-long condition (Hudson, 2016) related to literacy-related problems (Reid, 2007).

Literacy skills are inevitably important for school-age children since many courses rely on reading comprehension (Sarıpınar & Erden, 2010). Yet, it is known that *reading* is a domain that LD students frequently have problems (McCulley et al., 2013). It includes many skills, such as decoding, encoding, and spelling, but reading comprehension may be the most prominent one (Elleman et al., 2009; Westwood, 2016) because it is the act of acquiring knowledge from a written text (Shanahan, 2005). Comprehension of what is read bears considerable importance, especially for LD students since they already have poor reading comprehension performance (Sarıpınar & Erden, 2010) and vocabulary knowledge (Delimehmet-Dada & Ergül, 2019).

According to the NRP (2000), reading comprehension includes complex skills and cannot be understood without considering the role of vocabulary since they often go hand in hand during learning (Doğanay-Bilgi, 2017; Verhoven & Leeuwe, 2008). Thus, disrupted lexical capacity negatively influences reading comprehension (Joshi, 2005) and results in difficulties in comprehension. Since expository texts include unfamiliar (Dymock & Nicholson, 2010) and hard-to-understand technical words (Gersten et al., 2001), their comprehension becomes more challenging for LD students (Zimmerman & Reed, 2020). In this sense, teaching unknown words before reading can facilitate reading comprehension. However, vocabulary teaching may need to expand beyond the school setting since being an activity that requires more time and effort. At this point, technology may be utilized to handle time and space-related problems with teaching vocabulary in a school setting (NRP, 2000).

The technology could provide individualized, flexible, and multisensory learning environments to meet the diverse needs of students (Massey, 2008) both in and out of school (Cortiella & Horowitz, 2014). LD students are likely to need extra time to study

at their own pace, practice, and get feedback during their learning process (Vaughn et al., 2012). Technology also allows such students to practice at their own pace with proper feedback support (Jitendra & Gajria, 2011).

Overall, the relevant research also emphasized the use of technology in special education (Bouck et al., 2009; Chang et al., 2011) for LD, a disorder influencing one's performance in reading, writing, and math skills (APA, 2013). Moreover, many studies previously investigated the impacts of the use of technology specifically on LD students' reading (Decker & Buggey, 2014; Floyd & Judge, 2012; Kennedy et al., 2015; Keyes et al., 2016; White & Robertson, 2015), writing (Corkett & Benevides, 2016; Nelson & Reynolds, 2015; Tariq & Latif, 2016) and math skills (Irish, 2002; Shin & Bryant, 2017; Xin et al., 2017) and overall concluded the use of technology help improve students' the mentioned skills.

CHAPTER 3

METHODOLOGY

This chapter touches upon the study's overall design, methods, participants, data collection procedure and data collection tools, data analysis, trustworthiness, and the researcher's role.

3.1   Research Questions

The present study attempted to determine principles for designing an online learning material to support students with Learning Difficulties (LD) reading comprehension in an expository text through teaching technical vocabulary and assess the efficiency of this online learning material on their reading comprehension and vocabulary performance. In line with this purpose, the researcher sought answers to the following questions:

1. What are the design principles for developing an online learning material to support LD students' reading comprehension in an expository text through teaching technical vocabulary?
2. Does the developed online learning material affect the students' vocabulary scores?
3. Does the developed online learning material affect the students' reading comprehension scores?
4. What are the opinions of special education teachers and academicians about the materials and current use of technology to support the reading comprehension of LD students?

3.2 Research Method

The present study employed design-based research (DBR) to answer the research questions stated above. Although DBR is often used interchangeably with developmental/development research (Richey et al., 2004; van den Akker, 1999), design research (Reeves et al., 2005), design experiments (Brown, 1992), and formative research (Reigeluth & Frick, 1999) in the literature, this study adopts the term DBR (Design-Based Research Collective, 2003).

Barab and Squire (2004) define DBR as a "series of approaches" intending to yield novel theories, practices, and artifacts to explain and manipulate teaching and learning in actual settings (Plomp, 2013). It aims to systematically generate knowledge grounded in data acquired from practice (Richey & Klein, 2005). According to Wang and Hannafin (2005), DBR has five main characteristics: (1) pragmatic, (2) grounded, (3) iterative, interactive, and flexible, (4) integrative, and (5) contextual. The current study is an example of DBR for the reasons below.

First off, the present study is believed to combine theory and practice, as DBR highlights (Wang & Hannafin, 2005). It is basically based on a theory from the field of instructional technology and adopts the practice in the field of learning disabilities by applying a newly designed and developed material. Indeed, the field of instructional technology is also a combination of practice and theory (Seels & Richey, 1994). Thus, design-based research consisting of design, development, and evaluation processes in knowledge production seems to be more appropriate for utilizing the power of the harmony of theory and practice.

Secondly, DBR is known to be theory-driven (Wang & Hannafin, 2005). It aims to produce solutions for real-world problems in learning environments by identifying design principles of materials to be employed (Amiel & Reeves, 2008; Herrington et al., 2007). The current study is also based on a theory and aims to generate a solution for a real-world educational setting. In other words, a multimedia learning-based online learning material was designed and developed to support the reading

comprehension of LD students in an expository text through teaching vocabulary both in and out of the school.

Thirdly, Wang and Hannafin (2005) define DBR as "a systematic but flexible methodology aiming to improve educational practices through iterative analysis, design, development, and implementation" (p. 2) (Amiel & Reeves, 2008). Moreover, it emphasizes collaborating with stakeholders and practitioners while seeking a solution or designing a product (Anderson & Shattuck, 2012; Plomp, 2013). In DBR, participants are more than just subjects; they are treated as co-participants (Barab & Squire, 2004) or valuable participants (Amiel & Reeves, 2008) actively involved in all phases. The present study progressed iteratively through three main phases: analysis, design & development, and implementation & evaluation with the stakeholders. The researcher conducted an in-depth analysis with special education teachers and academics, and the outcomes of this phase shed light on the design process. Next, the draft online learning material was generated upon the results of the analysis phase. Then, the material was finalized through the active involvement of stakeholders throughout four design and development cycles and an implementation & evaluation phase. Besides, the current study relies on flexibility since the researcher modified the initial plan when needed.

Fourthly, multiple research designs and methodologies are widely used in different phases of design-based research (Anderson & Shattuck, 2012; Plomp, 2013; Richey et al., 2004; Richey & Klein, 2005). Likewise, DBR research combines widely adopted methods and data collection tools to enhance the validity (Wang & Hannafin, 2005). Accordingly, the current research is integrative because including qualitative and quantitative techniques with a variety of data collection methods (e.g., semi-structured interviews, observation, expert opinion, achievement tests, and a demographic information survey).

Finally, the current study is contextual because aiming to determine principles for designing an online learning material to support the reading comprehension of LD students in an expository text through teaching technical vocabulary and applying them in learning disabilities. DBR studies intend to produce models and principles

(Richey et al., 2004); therefore, DBR would be an appropriate choice to accomplish this aim.

In addition, DBR consists of two categories: Type 1 and Type 2. The research based on the former focuses on an instructional process, program, or product and seeks to describe general principles or recommendations for specific situations. Moreover, these studies address the design, development, and evaluation of a product (Richey & Klein, 2005) and generally reveal context-specific conclusions (Richey et al., 2004).

On the other hand, Type 2 studies focus on detailed design, development, and evaluation processes and models. Moreover, they include creating and validating previously specified design models and processes (Richey & Klein, 2005). For example, they may address explanations of an already designed model and uncover its weaknesses and strengths. Additionally, Type 2 studies result in more generalizable conclusions, unlike Type 1 research (Richey et al., 2004). The current study is an example of Type 1 DBR since it aimed to designate principles for designing an online learning material for LD students to support their reading comprehension in an expository text through teaching technical vocabulary.

3.3 Overall Design of the Study

The current study is an example of DBR comprising three main phases: analysis, design & development, and implementation & evaluation. It was initiated with an in-depth analysis phase, and the findings helped move on to the design and development phase, consisting of four iterative cycles with the stakeholders. Then, the implementation & evaluation phase helped determine the impacts of the finalized online learning material on students' reading comprehension and vocabulary scores. Finally, all the results in each phase were analyzed and documented to determine the design principles of the material. Figure 1 presents a detailed flowchart of the stages.
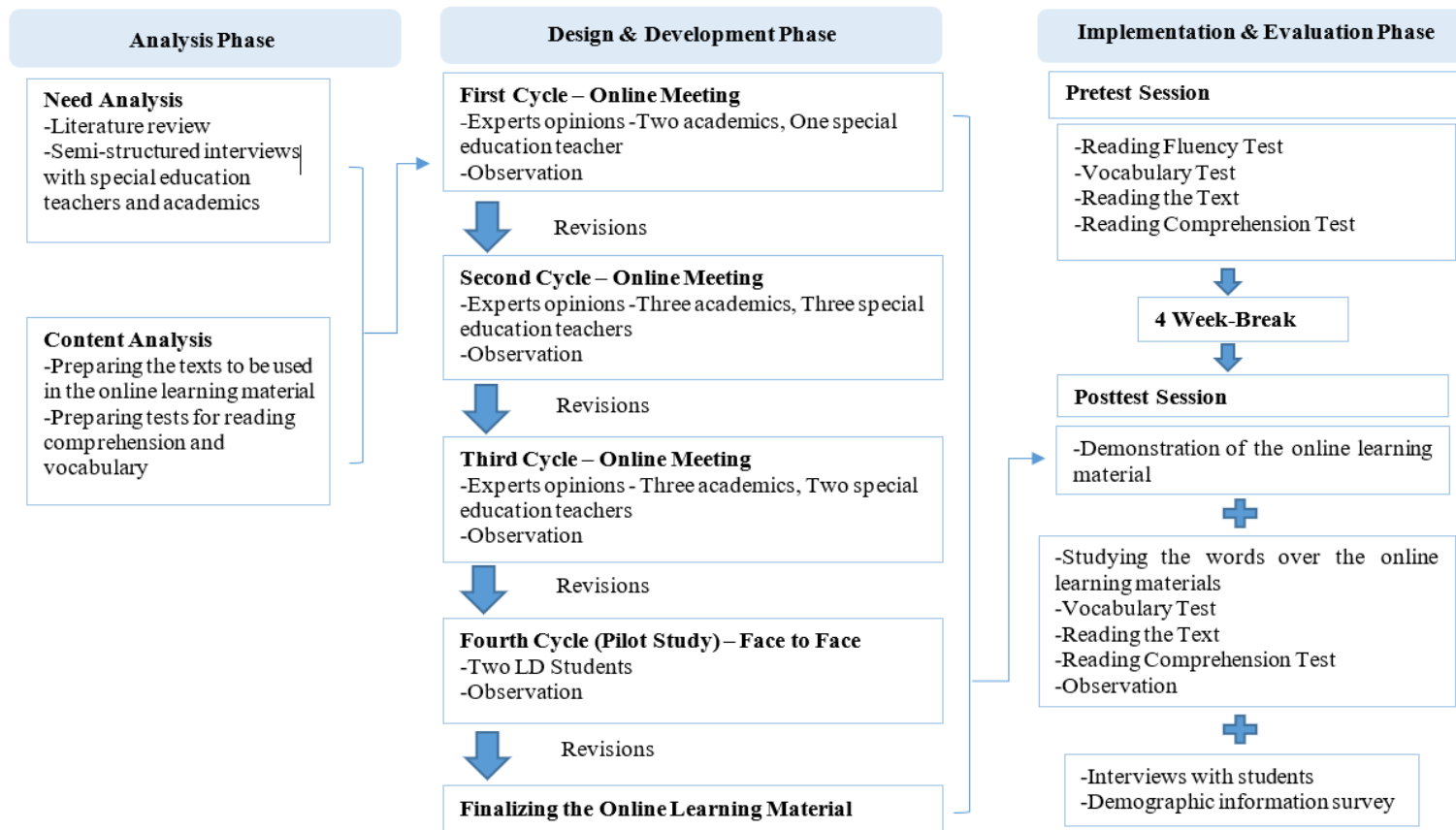
Figure 1. Overall design of the study

3.3.1 Analysis Phase

The analysis phase consisted of two sub-phases: need and content analysis. It started with a systematic literature review aiming to determine the skills focused on learning disabilities, the technologies used to enhance those skills, and the effects of technology on LD students' performance of these skills. The review aimed to designate methodological characteristics to promote the research design of the current study. Prior to the literature review, the researcher directed an initial search to determine the keywords used in the literature. The specified keywords were "Learning Disabilities," "Learning Difficulties," "Specific Learning Disabilities," "Computer Assisted Instruction," "Technology," and "Assistive Technology." These keywords were combined with the "AND/OR" operator. Next, the researcher searched peer-reviewed journals and full-text papers in English within Academic Search Complete (ASC), Education Resources Information Center (ERIC), and Education Source. Among 699 articles, 55 remained after eliminating exact duplicates and not empirical studies (reviews, reports, and synthesis). Then, the researcher examined these papers in detail regarding the skills they focused on, technologies they preferred to enhance the skills, and their methodologies and results.

The results showed that nearly half of the studies (n=27) focused on reading-related skills, and reading comprehension was the most studied skill (n=14). Moreover, text-to-speech and speech recognition software (e.g., Dragon Naturally Speaking, Kurzweil 3000, Strategic Reader, and Dragon Dictate) were the most common technology used to enhance reading-related skills. Besides, the papers reviewed adopted the single-subject design the most, and the participants often comprised elementary school students.
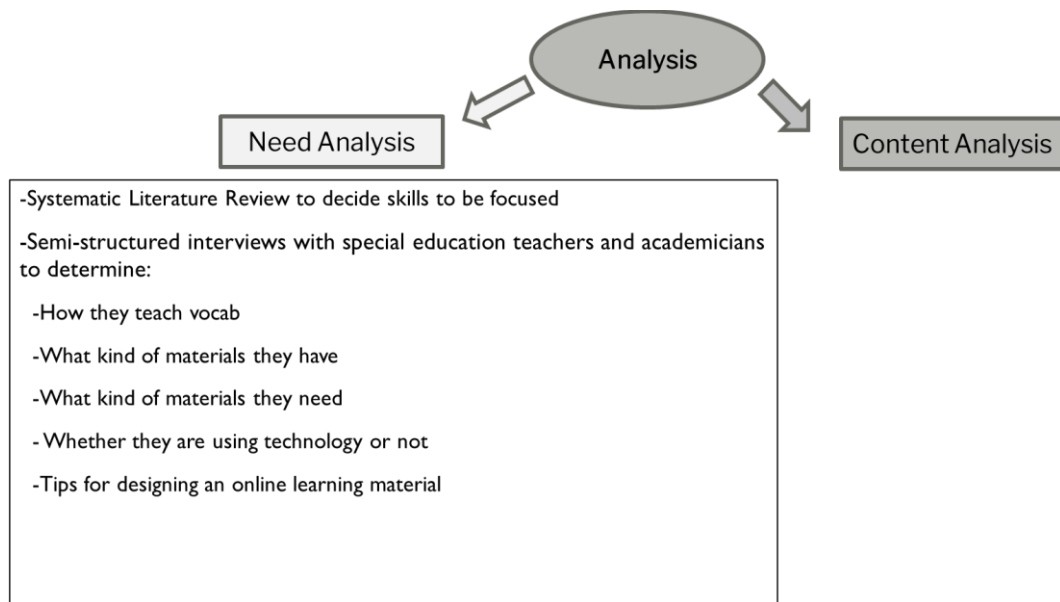
Figure 2. Needs analysis of the study

Following the literature review, the researcher interviewed seven special education teachers and four academics to conduct an in-depth need analysis. The purpose was to determine how they teach vocabulary and what kind of material they have and need to promote reading comprehension. Moreover, the aim was to learn whether they adopt technology and obtain their recommendations for designing the online learning material. This phase is often executed through qualitative research techniques (Richey et al., 2004). Qualitative research aims to bring an in-depth analysis of a phenomenon (Mills & Gay, 2016) and utilizes multiple sources of data collection tools such as interviews, observation, audiovisual materials, and documents (Creswell & Creswell, 2018; Fraenkel et al., 2012). The current study used the interview to collect data for the need analysis.

Content analysis was the second step of the analysis phase (see Figure 3). The researcher prepared texts and tests for reading comprehension and vocabulary with the help of subject matter experts. First, the researcher examined the Ministry of National Education (MoNE) science books to determine the texts to be used in the study. Next, she prepared four expository texts covering some technical vocabulary items.

Then, she used the readability formula developed by (Ateşman, 1997) to determine the readability of the texts. Accordingly, it was found that the texts had a readability of medium difficulty.
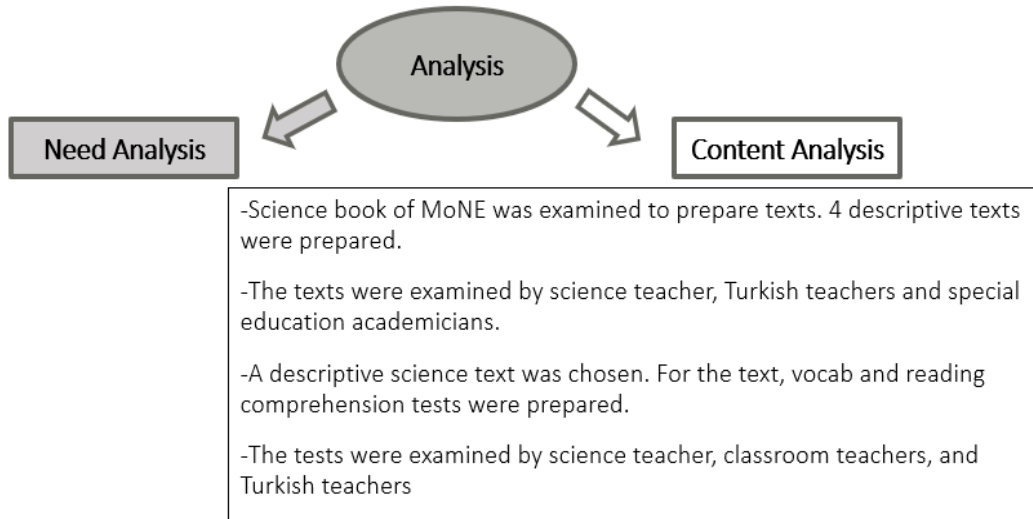
Figure 3. Content analysis of the study

Afterward, an elementary school science teacher with substantial experience working with LD students for more than 18 years re-edited the texts. Moreover, two classroom teachers, serving in a public school with more than 23 years of experience, evaluated the texts' appropriateness, content accuracy, and density for fourth-grade students. Then, five Turkish language teachers examined the texts, considering the quality (organization, selection of words, sentence structure, grammar, and consistency) and content (wording, ideas, and conceptual density). Among these teachers, one had six years of experience, whereas the others had more than 14 years of experience in public schools. Finally, the texts were evaluated by two academics tenured in the field of special education at a well-known state university for more than 28 years.

The subject matter experts and academics evaluated the texts using a five-point Likert-type scale designed by (Sanır, 2017) (see Appendices J and K). They scored the texts on the scale ranging from 1 (not appropriate) to 5 (most appropriate) for each category. Next, the researcher selected two texts with a score of four or more to use in the study for the fluency test and reading comprehension (see Appendix G).

After evaluating the texts, the researcher prepared a reading comprehension test (see Appendix H) and vocabulary test (see Appendix I) for one of the texts. A science teacher examined the questions, and three classroom teachers working in a public school evaluated the appropriateness and linguistic properties of the test items. These teachers had more than 24 years of experience in their subject matter area. Finally, a Turkish language teacher evaluated the test items regarding the organization, selection of words, sentence structure, grammar, and consistency.

3.3.2 Design and Development Phase

The second phase aimed to design and develop the online learning material upon the findings in the analysis phase. Figure 4 shows the design and development procedure in detail.
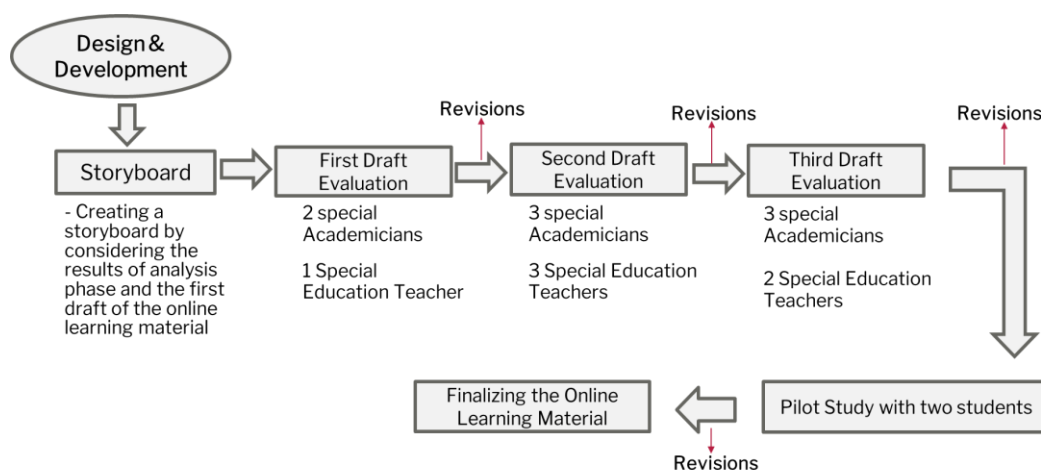
Figure 4. Procedure of the design and development phase

The design and development phase consisted of four iterative cycles conducted with the stakeholders: special education teachers and academics and LD students, as DBR highlights (Plomp, 2013). In each cycle, the researcher set exclusive online meetings with stakeholders except for students. Setting online meetings with LD students was not preferred because of the possibility of encountering technical problems during the session.

Firstly, the researcher created a storyboard for the online learning material for the developer team to design a draft material. Later, the researcher set online meetings

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with the experts. Before each session, the researcher sent a web link that stakeholders could reach and examine the online learning material. After a series of reviews, the researcher interviewed the stakeholders online. The experts shared their screens while using and commenting on the online learning material. The researcher recorded the sessions and took notes. After the meetings, the researcher collected all expert opinions and applied them to the material. Then, the experts re-evaluated the revised material through a couple of online sessions.

Following the meetings with the experts, the researcher directed the final design and developmental cycle, a pilot study with two fourth-grade LD students face-to-face. It aimed to observe students while using the online learning material and determine any problems they might confront. The pilot study sessions were conducted with students separately in a classroom where students attend their classes. The students were informed about the research at the beginning of the session. Then, a demonstration session was conducted to show them how to use the online learning material. Next, students used the material by using a laptop and a mouse themselves. Two researchers observed students by sitting behind and they took notes during the pilot study. After the pilot study, the observers analyzed their notes and discussed the necessary revisions needed to the improve online learning material. Finally, the researcher and developer team made necessary improvements to the material upon the observation notes.

The COVID-19 Pandemic

The COVID-19 pandemic had some effects on students, teachers, and the learning process. First of all, it resulted in very-limited face-to-face interaction. Therefore, the researcher worked with students individually and had to wear masks during the study. Secondly, students or their families got COVID. Thus, some of them could not come to school and attend study. Thirdly, teachers and academicians tend to use online platforms and materials more because they directed online lessons during the pandemic. In the design and development cycles, the researcher met with experts using an online platform. The experts' tendency to use online platforms and material helped

to conduct the meetings easier. Moreover, students also had experience working on online platforms and materials.

The Online Learning Material

After the revisions, the researcher and developer team finalized the online learning material. The developer team was consisting three undergraduate students taking the "Project Management" course from the CEIT department. The students and the researcher worked collaboratively during the year and developed material together.

The finalized material has three main modules: introduction, vocabulary, and reading comprehension. Firstly, the introduction module is where students can customize the online learning material for themselves. As shown in Figure 5, students are supposed to select an avatar, font type, font size, and background color that they can read easily. Moreover, the material includes a screen that allows students to write their names or nicknames.
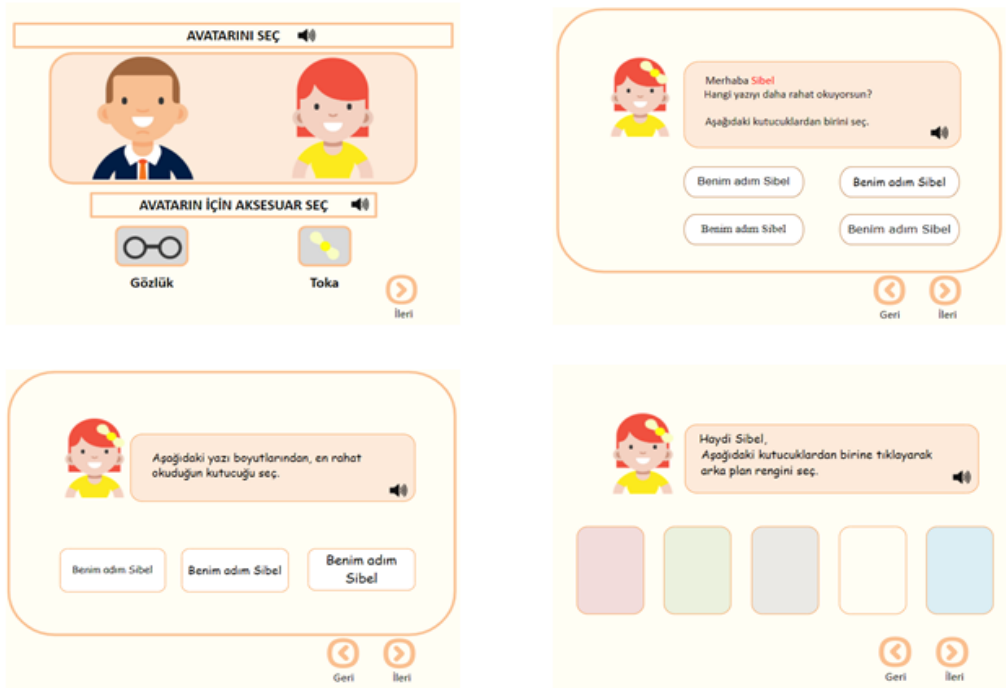
Figure 5. The introduction module of the online learning material

Vocabulary is the second module of the online learning material. In this module, the students first learn target words, namely "pure substance," "mixture," "sieving," and "filtering," exclusively in a multimedia learning environment. The vocabulary module consists of vocabulary teaching, practice, and vocabulary test parts.

In this module, the target words are highlighted and defined. Then, there are visuals consisting of five examples and two non-examples of the words. The next screen consisted of an animation or a video for each word, as seen in Figure 6. Moreover, a speaker icon is on all screens to vocalize the texts if students want to use them.

Figure 6. The vocabulary module of the online learning material

Moreover, there is a screen consisting of all the examples presented in the material about each word. The visuals related to each other are grouped and placed closely to help students connect and remember them easily. Furthermore, there is a transition screen after each word is dictated. It aims to show students the words they have accomplished and the remaining words they will learn. Those screens are designed to

prepare students for the next task. They are also used when students pass the tests before and after reading the text. For example, there is an example screen for the word "mixture" in Figure 7. The figure shows the examples of screen covering the visuals belonging the word "mixture" and a transition screen for the next word.
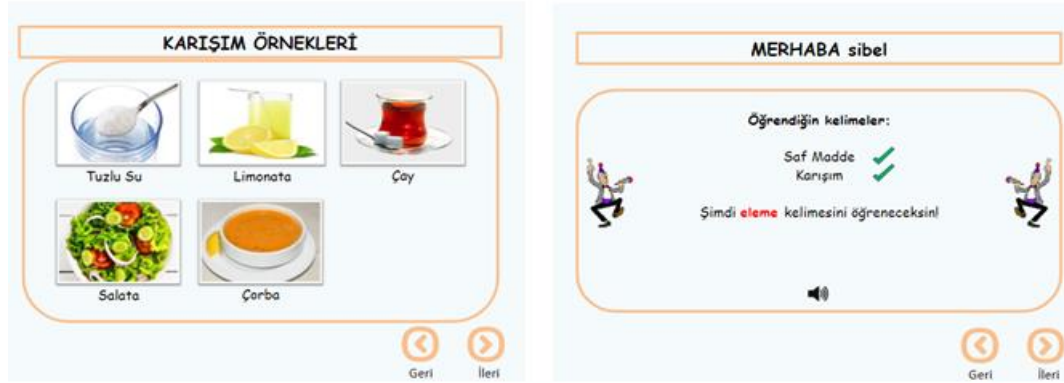
Figure 7. The vocabulary module of the online learning material

Secondly, there is a practice part consisting of four interactive screens in the second module. In the practice part, students have a chance to practice what they have learned about the word with the help of immediate feedback. Figure 8 shows the example screens for the word "mixture." There are fewer texts and more interactions in the practice part to keep students' attention and help them do the practice without getting bored. In this part, students are just supposed to select or drag and drop the answer they think is correct and get immediate feedback. Students cannot skip any questions without finding the correct answer to them. Supposing that students cannot find the correct answer, they can return to the vocabulary teaching part with the "Return the Subject" button. The button helps them to go back to the related subject. If they do not want to dictate the whole subject, they can return to the related question again.
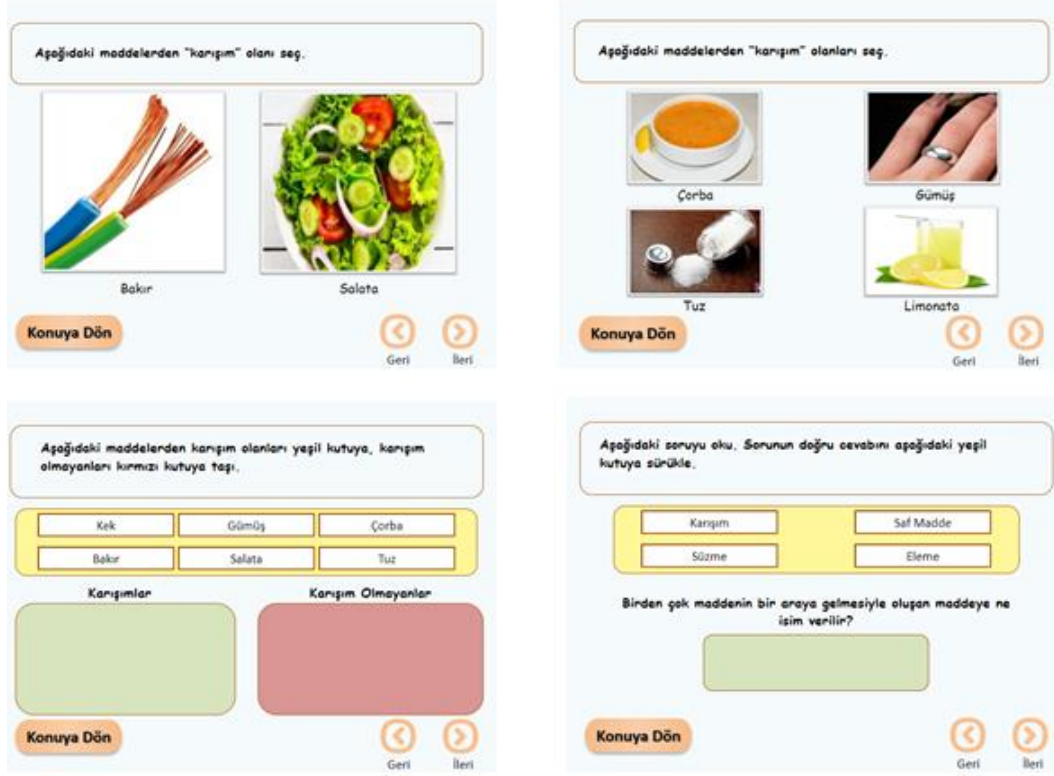
Figure 8. Sample screens for the vocabulary practice

Thirdly, students take a vocabulary test as the last part of the vocabulary module. There are ten questions in the vocabulary test, including multiple-choice, drag and drop, and pick many. Students cannot pass any questions without answering them. Following the test, students can see the number of their correct and wrong answers in a graphic. They also have a chance to review their responses and get feedback or pass to the next task. Figure 9 shows sample screens for the vocabulary test part.
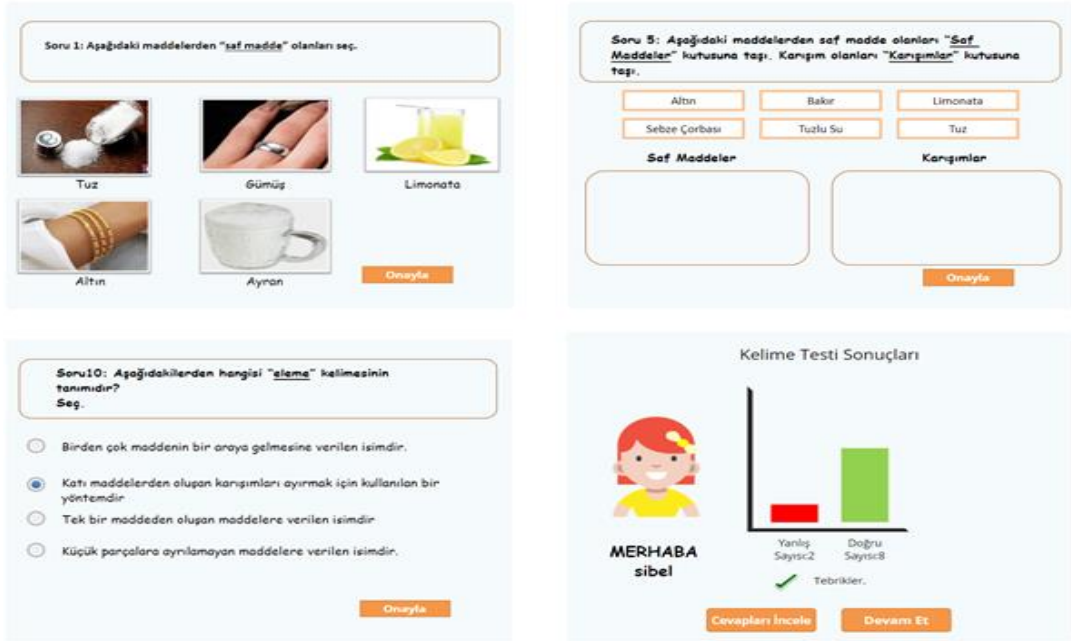
Figure 9. Sample screens for the vocabulary test

Reading comprehension is the third module and consists of word drills, text reading, and a reading comprehension test. Firstly, the students have a chance to review the words they have practiced before reading the text. They would first see the highlighted definitions of the essential, as shown in Figure 10. Then, the text comes up in the next screen. On that screen, the students may change the font size of the text to read it easily. After reading the text, a transition screen warns students that the following part includes reading comprehension questions. The students can pass the test direclty or go back to the text to read it again.
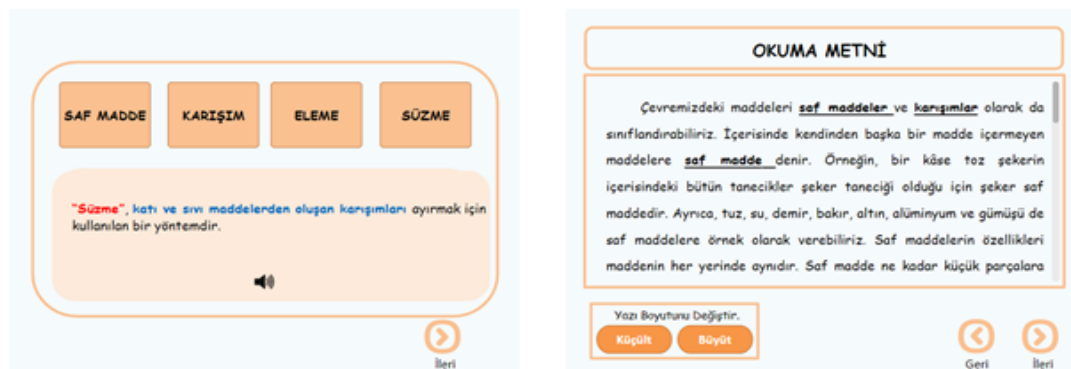
Figure 10. Sample screen from Reading comprehension module

The reading comprehension test is the final part of the reading comprehension module. The test consists of fourteen multiple-choice questions about the text, and students are supposed to solve each question. Following the test, they can see their scores in a graphic and review their answers to obtain feedback, as shown in Figure 11.

Figure 11. Sample screen from reading comprehension module

3.3.3   Implementation & Evaluation Phase

The present study adopted DBR design. DBR is a research design covering different methodologies in different phases (Anderson & Shattuck, 2012). Thus, a one-group pretest-posttest design was utilized in the implementation & evaluation phase to determine the effects of the online learning material on the students' reading comprehension and vocabulary performance. It is a kind of poor experimental design (Fraenkel et al., 2012) or pre-experimental design with only one group, unlike true experimental and quasi-experimental studies (Creswell, 2017; Creswell & Creswell, 2018).

One-Group Pretest-Posttest Design

This design includes a pretest measure followed by a treatment and a posttest for a single group.

Group A *01————X————02*

Figure 12. One-group pretest-posttest design (Creswell, 2017)

In this design, the independent variable was determined to be vocabulary teaching through the online learning material, while the dependent variables were reading

comprehension and vocabulary test scores. The students were selected using the purposive sampling method among those satisfying pre-determined certain criteria. The criteria were being a fourth-grade student, having LD recognition, reading without spelling and having no other disability type.

Twenty-eight fourth-grade students attended the pretest session, the researcher put a four-week break. Then, thirteen students were included in the posttest session because some of the students having attended the pretest were absent during the posttest measurement or did not want to attend the posttest session. The experimental designs often include two groups as control and experimental (Fraenkel et al., 2012). In the current study, the control and experimental groups were the same; the students in the experimental group were also in their control group because of the small sample size.

The implementation & evaluation phase was initiated with the pretest session. The students took the reading fluency, vocabulary, and reading comprehension tests in the pretest session. First, they read a text prepared in the analysis phase. While reading, the researcher recorded how many words they read correctly in a minute. Next, the students took the vocabulary test to assess their lexical capacity. Finally, they participated in a reading comprehension test. During the pretest procedure, the researcher recorded start/end times and ensured they read all the questions. If students skipped any of the questions, the researcher warn them to read the question. Moreover, the students took all the necessary time in the pretest and posttest sessions.

The exact text and the tests were used in the pretest and posttest sessions. The researcher gave a four-week break between the test so that the students do not remember what they had read in the pretest session.
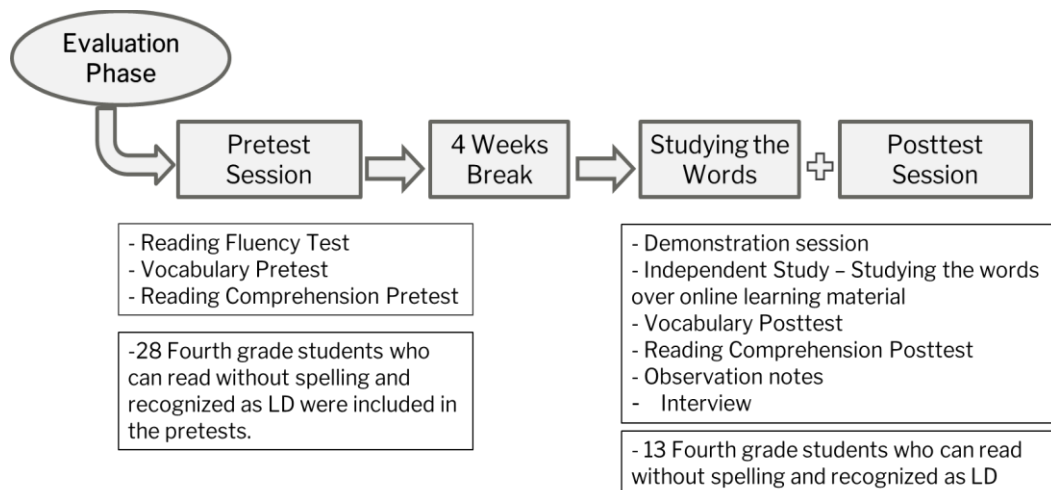
Figure 13. Implementation & evaluation phase of the current study

As it can be seen from Figure 13, thirteen students attending the pretest were included in the posttest session. Prior to the session, the researcher explained to students what they would do respectively and made a demonstration session to show students how to use the material. Next, the students worked on the online learning material themselves and asked for help when needed. The researcher observed the student behind the session venue and filled out an observation rubric. The students were taught four words in the online learning environment and attended a vocabulary test. Then, they read a text and took the reading comprehension test. The online learning material saved all the scores in the database. Finally, the researcher held a semi-structured interview with each student about their experience with the material.

3.4 Participants

The current study is an example of a DBR embodied with qualitative and qualitative research techniques. Although different participant groups were included in each phase, as DBR highlights (Richey & Klein, 2005), all the participants were selected using the purposive sampling method.

The ultimate aim of qualitative research is to suggest an in-depth understanding of a phenomenon, and participants in this research are often selected using purposive sampling techniques (Mills & Gay, 2016; Yıldırım & Şimşek, 2016). Purposive sampling is a method to select people who are believed to contribute to the study and

help the researcher(s) to understand a problem the best (Creswell, 2017; Creswell & Creswell, 2018). Moreover, it allows the researcher(s) to select a sample based on their previous experience with the population (Fraenkel et al., 2012). The experts and teachers were selected by considering their expertise in the field and their research interests.

The current study also utilizes quantitative methodologies. In quantitative studies, participants are selected using random and non-random sampling methods (Mills & Gay, 2016; Fraenkel et al., 2012). There was no chance to conduct randomization while selecting participants in the current study because of the small sample size, and the researcher had to determine some selection criteria to reach a specific group of students. Thus, purposive sampling was considered an appropriate sampling method to recruit the participants (Mills & Gay, 2016). In this regard, two academics with more than 30 years of experience in learning disabilities determined the criteria to reach the target group of students who would benefit from the online learning material best. The determined criteria were having LD recognition, having no other disability type, being a fourth grade student, and reading without spelling.

Below is a detailed demonstration of the sampling. First, the study was initiated with the need analysis phase. The researcher conducted interviews with four academics and seven special education teachers in this phase. Learning disabilities were among the main research interests of the selected academics who were employed in the special education department of a state university (coded as A1, A2, A3, and A4). While two of them had at least ten years of experience, the rest had more than 25 years of experience in special education and learning disabilities.

Table 1. Demographic information of the analysis phase participants

Participants	Occupation	Field of Expertise	Institution	Experience
A1	Academic	Learning Disabilities	State University	38 years
A2	Academic	Learning Disabilities	State University	28 years
A3	Academic	Learning Disabilities	State University	11 years
A4	Academic	Learning Disabilities	State University	16 years
SET1	Teacher	Special Education	Special Ed. and Rehabilitation Center	4 years
SET2	Teacher	Special Education	Special Ed. and Rehabilitation Center	4 years
SET3	Teacher	Special Education	Special Ed. and Rehabilitation Center	3 years
SET4	Teacher	Special Education	Special Ed. and Rehabilitation Center	3 years
SET5	Teacher	Special Education	Special Ed. and Rehabilitation Center	13 years
SET6	Teacher	Special Education	Special Ed. and Rehabilitation Center	17 years
SET7	Teacher	Special Education	Special Ed. and Rehabilitation Center	14 years

Afterward, the researcher interviewed seven special education coded as SET1, SET2, …, and SET7. SETs were employed in a special education and rehabilitation center affiliated with the MoNE in Ankara. Four had at least four years of experience in special education, while the rest had more than thirteen years of experience.

The analysis phase was followed by the design & development phase. This stage consisted of four iterative cycles with the active involvement of the stakeholders. Three academics, three special education teachers, and two LD students were recruited for this phase (See table 2).

Table 2. Demographics of the experts included in the design & development phase

Participants	Occupation	Field of Expertise	Institution	Experience
A5	Academic	Special Education	State University	23 years
A6	Academic	Special Education	State University	7 years
A7	Academic	Special Education	State University	7 years
SET1	Teacher	Special Education	Special Ed. and Rehabilitation Center	4 years
SET8	Teacher	Special Education	Special Ed. and Rehabilitation Center	5 years
SET9	Teacher	Special Education	Special Ed. and Rehabilitation Center	18 years

A5 was an academic with more than 20 years of experience in special education, specifically the use and integration of technology in special education. A6 was a Ph.D. student with seven years of experience in the field, while A7 spent seven years in research in the field. All the academics were employed in the special education department of a well-known state university. On the other hand, SET1, SET8, and SET9 were special education teachers serving in a special education and rehabilitation center. SET1 and SET8 had more than four years of experience, while SET9 had been working for 18 years in that institution.

The pilot study was the last cycle of the design & development phase, and two students (S1 and S2) were recruited for the pilot study. Both students were enrolled in fourth grade and diagnosed with LD without any other disability types.

Table 3. Demographics of the students included in the design & development phase

Participants	Gender	Grade	LD Diagnosis	Other Disability Type
S1	M	4	Yes	No
S2	M	4	Yes	No

The implementation & evaluation phase was the final step of the current study. In this phase, there were thirteen fourth-grade LD students. All students were enrolled in the special education and rehabilitation center (S3, S4, …, and S15). They were all fourth-

grade students recognized as LD and had no other disability types. All students also attended public schools in Ankara.

Table 4. Demographics of the students included in the evaluation phase

Participants	Gender	Grade	LD Recognition	Other Disability Type
S3	F	4	Yes	No
S4	F	4	Yes	No
S5	F	4	Yes	No
S6	F	4	Yes	No
S7	M	4	Yes	No
S8	F	4	Yes	No
S9	M	4	Yes	No
S10	F	4	Yes	No
S11	F	4	Yes	No
S12	F	4	Yes	No
S13	M	4	Yes	No
S14	F	4	Yes	No
S15	F	4	Yes	No

3.5 Data Collection

Prior to data collection, the Research Ethics Committee of Middle East Technical University (METU) and the MoNE ethical approval and relevant permissions to the present study, respectively (see Appendices A and B). Then, the participants were informed about the study and asked to provide their written consent for voluntary participation (see Appendix C). Moreover, the LD students' parents signed a consent form (see Appendix D) for their children's participation in this study. Table 5 presents the data collection tools utilized in the current study.

Table 5. Data collection tools and analysis techniques

Phase	Data Collection Techniques	Data Analysis
Analysis	Interviews	Qualitative analysis
Design & Development	Expert opinions Observation	Qualitative analysis
Implementation & Evaluation	Reading comprehension and vocabulary tests, Interviews, observation	Wilcoxon signed-rank test Qualitative analysis

3.5.1 Data Collection Tools

The current research includes both qualitative and quantitative data collection techniques. Specifically, the data were collected through interviews, observations, expert opinions, and achievement tests in the current study. The data collection tools are explained in detail below.

3.5.1.1 Interview protocol

Interview is a widely adopted main data collection tecnhique in qualitative methodologies (Creswell & Creswell, 2018; Fraenkel et al., 2012). According to Yıldırım and Şimşek (2016), interviews can be categorized as semi-structured and structured. The *interview protocol* is one of the main data collection tools used in the current study. Semi-structured interviews were held with special education teachers, academics, and LD students.

Firstly, the researcher held a series of semi-structured interviews with four academics (Appendix E) and seven special education teachers (SET) (Appendix F) for the need analysis. While the first part of the interviews was about collecting demographic characteristics of the participants (e.g., educational attainment, experience in special education, and research interests), the second part inquired about their strategies to support reading comprehension, materials they have/need to promote reading comprehension and vocabulary, their thoughts on technology usage in special education, and their recommendations for designing an online learning material to support reading comprehension through teaching vocabulary. The researcher also held semi-structured interviews (Appendix L) with the students in the implementation & evaluation phase to understand their awareness of the words they learned and their opinions about the online learning material.

While preparing the interview protocols, expert opinions were taken to ensure the credibility issue. The experts reviewed the questions regarding clarity, organization, and validity. Firstly, two doctorate students from Computer Education and Instructional Technology (CEIT) reviewed the questions. Following an initial revision of the question upon the feedback from the doctorate students, the researcher revised

once more time on the subsequent feedback from two academicians from the department of CEIT and special education. The revisions were related to the wording and clarity of the questions. No of the items were removed.

3.5.1.2 Observation Forms

Observation is another common technique used in qualitative studies (Creswell & Creswell, 2018). It is a process of observing participants and taking notes of what they are engaged in (Fraenkel et al., 2012). In the current study, the researcher conducted observations in the design & development, and implementation & evaluation phases.

Firstly, the researcher observed the experiences of the academics, special education teachers, and LD students participating in the design & development cycles. The researcher did not use any observation checklist but took notes during their experiences. Following each design & development cycle, the researcher combined the notes taken. In the last design and development cycle, pilot study, an observer also observed students' experiences and took notes. When the pilot study was over, the researchers discussed their notes and combined them.

The implementation & evaluation phase also included observation technique with two observation forms. Firstly, the researcher prepared an observation form (Appendix M) to observe students in the pretest session to note down whether the students responded to all questions and their response time. If students skipped any of the questions, the researcher warned them to read the question. The researcher also designed an observation form (Appendix N) for the posttest session to record the students' actions (e.g., avatar selection, using the button to go back to the subject part, reviewing answers, and considering graphics or examples). It was for understanding their interactions/experiences with the online learning material. The researcher herself filled out the form to keep an organized record of the students' behaviors. The observation forms were reviewed with a doctorate student has experience in qualitative studies.

3.5.1.3 Expert opinion

Expert opinion was used in the design and development phase. After preparing the initial draft of the online learning material, the researcher set online meetings with the

experts to elicit their opinions and recommendations about the material. There were three design and development cycles performed with the experts. A web link was sent to the experts so that they could reach the online learning material and examine it before each meeting. The researcher recorded the sessions where the experts shared their screens and commented on the online learning material via voice recorder. Then, the records were transcribed and coded.

3.5.1.4 Vocabulary and Reading Comprehension Tests

The current study aimed to determine principles for designing an online learning material to promote LD students' reading comprehension in an expository text through teaching technical vocabulary. Moreover, it investigated the effects of the online learning material on students' reading comprehension and vocabulary performance. For this reason, the researcher prepared reading comprehension (Appendix H) and vocabulary (Appendix I) tests with the help of subject matter experts. The tests were prepared according to the expository text titled "Pure Substance and Mixtures (Saf Maddie ve Karışımlar)" prepared in the analysis phase to be used in the current study.

There were ten questions on the vocabulary test and fourteen on the reading comprehension test. The prepared tests were examined by subject matter experts namely: science teacher, classroom teachers, and Turkish teachers. Firstly, a science teacher, who also has experience with LD students, reviewed the test items in terms of content appropriateness and accuracy. Then, three classroom teachers examined the questions in terms of appropriateness for a fourth-grade student. Lastly, a Turkish teacher and a classroom teacher who has a bachelor's degree in the area of Turkish Language reviewed the test items regarding the appropriateness of the items, organization, selection of the words, sentence structure, grammar, and consistency. In addition, the test items were tested with two LD students who participated in the pilot study to be sure about understandability and clarity. Then, necessary revisions were applied to the questions. The revisions that experts provided were generally about the clarity of the questions. The experts shortened some of the sentences and changed the wording.

3.5.1.5 Demographic Questionnaire

The demographic questionnaire (Appendix O) was used in the current study to gather information on students' grade level, educational background, and disabilities. The grade level was essential because the target group should consist of fourth-grade students faced with expository texts. Moreover, knowing students' disability background was crucial to be sure that their main difficulty area was LD and whether or not they have recognition.

3.5.2 Data Collection Procedure

The current study is an example of DBR consisting of three phases: analysis, design & development, and implementation & evaluation. The data collection procedure in each phase is revealed below.

Analysis Phase

The study was initiated with an analysis phase. The researcher planned to conduct interviews with experts to make an in-depth analysis, as qualitative research implies. The researcher then sent e-mails to the relevant academics and contacted a special education and rehabilitation center in Ankara. After informing the potential participants about the purpose of the study, participants were asked to provide their written consent before the interviews.

Interviews were held with four academics and seven special education teachers to settle the situation from different perspectives. The researcher started interviews with the academics and visited them at the universities they were employed. Then, the teachers, employed in a special education and rehabilitation center affiliated with MoNE in Ankara, were recruited for the interviews. The interviews were conducted in the teachers' classrooms.

The researcher recorded the interviews using a voice recorder and stored the recordings on a hard drive with unique codes for each participant. The interviews were attempted to be held in the interviewees' natural settings (e.g., their rooms or classrooms), as

qualitative research highlights (Creswell, 2017; Creswell & Creswell, 2018; Fraenkel et al., 2012).

Design & Development Phase

Expert opinions and observation forms were the primary data collection tools in the design and development phase. The teachers, academics, and LD students were included in this phase. The teachers and academics attended the first, second, and third design and development cycles, while the LD students participated in only the last cycle, the pilot study.

The researcher contacted three special education teachers and three academics through e-mail after designing the initial draft of the online learning material. Then, the experts were invited for a series of online meetings to improve the draft material. Before each session, the researcher sent the participants the web link to the material to allow them to examine the material before the session. During the sessions, the experts were asked to share their screens, use the material, and comment on it. The researcher observed the experts while using the material and noted down their recommendations, as well as recorded the meetings with a voice recorder. Following each session, the researcher transferred the notes into a Word file and stored the recordings on a hard drive with unique codes for each participant. When the first design and development cycle was completed, the researcher combined all the recommendations and observation notes to carry out necessary revisions to the online learning material. She set online meetings for the second design and development cycle with the experts when the developer team revised the material. Then, she repeated all the steps shown in Figure 14 for the second and third design & development cycles.
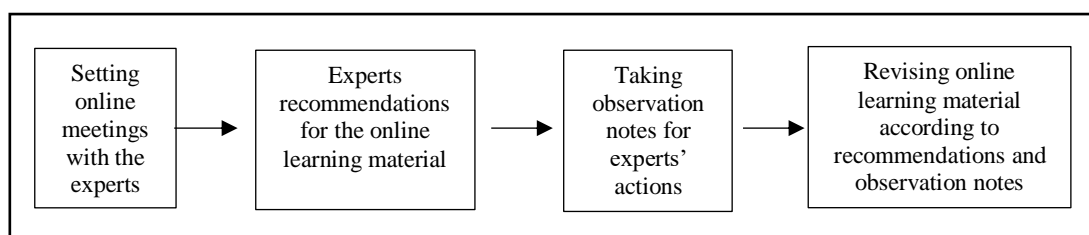
Figure 14. Data collection procedure for the expert opinions

The recommendations on the third cycle showed no need for another round of meetings with the experts. Thus, the researcher contacted a special education and rehabilitation center to conduct the pilot study with students. Two fourth-grade LD students attended the final design and development cycle separately in a classroom of the special education center. The students were explained what and how to do when using the material. Then, the researcher and another developer team member observed students' actions, took notes, and helped the students when needed. Following the pilot study, the researcher finalized the material with relevant revisions upon their notes and observations.

There was a developer team in the design and development phase to assist the researcher. Three senior CEIT students at METU worked collaboratively with the researcher during design and development cycles.

Implementation & Evaluation Phase

The last phase employed a pretest-posttest design. The data were collected through reading comprehension and vocabulary tests, semi-structured interviews with the LD students, observations, and a demographic information survey. Following the design and development cycles, the researcher contacted a special education and rehabilitation center to investigate the effects of the online learning material on students reading comprehension and vocabulary performance. Accordingly, the school education coordinator determined all fourth-grade LD students. The students were asked to fill out a demographic information survey (Appendix O) to collect information about their demographic characteristics, educational attainment, and disability background. While 28 fourth-grade students attended the pretest, and only thirteen of the students participated in the posttest. The school administration granted a classroom for the researcher to work with students in the pretest and posttest sessions.

The implementation & evaluation phase was initiated with the pretest measurements. The researcher introduced herself and explained what they would do to each student. Then, she administered the reading fluency, vocabulary, and reading comprehension tests, respectively. The students also read a text for the reading comprehension test.

The researcher informed students about each test and expressed that they could use all the time they would need and that they should read the items carefully. Then, the researcher observed and filled out an observation form (Appendix M) while the students were engaged in the tests. Following the pretest measurements, the researcher left a four-week break to take posttest measurements.

In the posttest, the researcher worked with thirteen students having attended the pretest session. She explained the students what they would do in the session and instructed them to study the words on the online learning material and take the tests. Then, she demonstrated the online learning material to the students. The students used laptops to study the online learning material, and the researcher sat behind the students and observed them by filling out the observation form (Appendix N). She also helped the students when needed.

While studying the online learning materials, the students first learned the words and took the vocabulary test. Next, they read the reading comprehension text and solved the reading comprehension questions. The online learning material saved the scores of the students. The students took the necessary time in all these steps, like in the pretest. After the students had finished all the steps, the researcher recruited them for interviews (Appendix L). The interviews took approximately 3-4 mins and were recorded with a voice recorder.

3.6   Data Analysis

The data in the study were collected using interviews with the stakeholders, observation notes, expert opinions, achievement tests (reading comprehension and vocabulary tests), and the demographic information survey. The reseracher analyzed the data as follows:

Interviews and Expert Opinions

Interviews and expert opinions were analyzed using qualitative data analysis, a technique used for extracting meaningful data from the raw data (Fraenkel et al., 2012). The researcher utilized the steps offered by Creswell and Creswell (2018) while analyzing the data.

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Organize and prepare the data for analysis. Firstly, The researcher transcribed the raw data into a Microsoft Word file to organize and prepare them for analysis.

Read or look at all the data. The researcher rechecked the transcriptions a few times by cross-checking the recordings to overcome missing data and become familiar with the raw data.

Start coding all of the data. The researcher read the transcriptions line by line and tried to code the data by dividing it into chunks explaining a category.

Generate a description and themes. After coding the raw data, the researcher clustered codes under related categories and themes and prepared an Excel sheet to combine quotes from multiple participants for each theme.

Representing the description and themes. The researcher combined all themes, related categories, and codes with quotes from the different participants. Then, the findings were presented in detail in the result chapter.

It is an iterative process to create codes, categories, and themes, and they were revised during qualitative data analysis. After coding all the interviews, the researcher invited a second researcher, a Ph.D. candidate in the field of education with substantial experience in qualitative research. The researcher informed her about the background of the study and asked her to recheck the generated codes and code a few interviews (10%). Then, they compared and discussed their codes and concluded considerable intercoder agreement (90%) based on the reliability coefficient formula by Miles and Huberman (1994). On the other hand, the codes that the coders could not settle were clustered in another category or removed from the coding table. After all, the two researchers organized the coding table together.

Observation

Observations were conducted to describe how participants reacted while using the online learning material during the design & development and implementation & evaluation phases. The researcher took observation notes for each participant in those phases and examined the notes to seek common points. The researcher made these

observations herself both in the design & development cycles except for the last one and the implementation & evaluation phase. However, the pilot study had two observers in the final design & development cycle. Following the pilot study, the observers combined and discussed their notes.

Reading Comprehension and Vocabulary Tests

Reading comprehension and vocabulary tests were the data collection tools used in the implementation & evaluation phase. The same tests were used both in the pretest and posttest sessions. In the pretest session, hardcopy versions of the tests were distributed to the students, and the researcher first scored them. Then, these tests were also scored by a doctorate student mentioned above. Finally, the results were compared, and mistaken scores were corrected.

On the other hand, reading comprehension and vocabulary tests were integrated into the online learning material in the posttest. Since the online learning material saved the students' scores, the researcher did not need to score the tests. After all the sessions were over, the pretest and posttest results were transferred into an Excel sheet. Then, the thirteen students' pretest and posttest reading comprehension and vocabulary scores were compared using the Wilcoxon signed-rank test, an alternative non-parametric test.

3.7 Trustworthiness of the study

The researcher considered the trustworthiness issues throughout the data collection and analysis process to fortify the research design. Trustworthiness is about validity and reliability. Despite being quantitative-oriented, validity and reliability are essential criteria for any research in ethical aspects (Creswell, 2017; Yıldırım & Şimşek, 2016). According to Lincoln and Guba (1985), trustworthiness is about persuading the readers that the research results are worth paying attention to and accounting for. Trustworthiness bears the following criteria: credibility, transferability, dependability, and confirmability (Creswell & Miller, 2000; Lincoln & Guba, 1985). Although the present research adopted a mixed method approach, it primarily utilized qualitative methodologies; thus, trustworthiness and related criteria were considered in the data

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collection and analysis phases. Table 6 presents detailed information about the trustworthiness of the current study.

Table 6. Trustworthiness of the current study

Criteria	Techniques	
Credibility (internal validity)	Triangulation	**Multiple sources**: -different data collection tools (interview protocol, expert opinions, and observation form) -different sources (academicians, teachers, LD students) **Multiple investigators** -having another observer **Multiple methods** -qualitative and quantitative methods
	Peer Debriefing	-Doctoral Steering Committee -Another Ph. D. candidate -Special Education Teacher
	Prolonged engagement	-Researcher spent more than one moth in a special education and rehabilitation center
Transferability (External Validity)	Think-rich description	-The research design, the procedures of design & development of the online learning material, methodology, and findings were explained in detail
Dependability (Reliability)	Intercoder agreement	-A doctorate student coded the interview data -A doctorate student scored the reading comprehension and vocabulary test scores
Confirmability (Objectivity)	Reflexivity	-Researcher role was explained

3.7.1 Credibility

Credibility, internal validity for quantitative studies, deals with whether the research findings truly depict "what it is ultimately intended" (Lincoln & Guba, 1985, p. 296) or the researcher(s) measure "what they think they are measuring" (Merriam, 2009, p. 213). In a qualitative study, the researcher may conduct different procedures, such as prolonged engagement, triangulation, persistent observation, member checking, and peer debriefing, to establish credibility (Creswell, 2017; Lincoln & Guba, 1985). In this regard, the current study adopted triangulation, peer debriefing, and prolonged engagement to enhance credibility.

Triangulation is a strategy used to improve the validity of research findings ((Miles & Huberman, 1994). It is a procedure where the researcher looks for convergence among different and multiple information sources and methods (Creswell & Miller, 2000; Creswell, 2017; Creswell & Creswell, 2018; Merriam, 2009). According to Denzin (1978), there are four types of triangulations: multiple sources, investigators, methods, and theories.

Regarding triangulation, this study utilized various sources, investigators, and methods. First, the researcher adopted interviews, expert opinions, and observation to collect data and combined all results from these tools while presenting the findings. Moreover, the data collection procedure included different participant groups. While directing interviews with special education teachers, academics, and LD students, the researcher also obtained expert opinions from different special education teachers and academics.

In addition, the study employed different investigators in the data collection phase. While a researcher assisted with observations in the pilot study, another researcher participated in the analysis of the qualitative data to minimize researcher bias. Finally, method triangulation was adopted to reveal the effects of the online learning material on the students' performance upon comparing the results gathered from quantitative (pretest and posttest reading comprehension and vocabulary test scores) and qualitative methods (interviews and observations).

Peer debriefing is a strategy for establishing credibility. It highlights the collaboration between the researcher and external reviewer/s (Creswell & Miller, 2000; Merriam, 2009). The prominent role of the debriefer is to ensure researchers be aware of the process (Lincoln & Guba, 1985). The debriefer asks questions and provides feedback on the research design, data collection and analysis procedures, and findings to enhance the quality of the research (Yıldırım & Şimşek, 2016). In the current study, Doctoral Steering Committee always provided feedback and recommendations for the research. Moreover, the researcher obtained feedback during data collection and analysis from one of her colleagues, a Ph.D. candidate with substantial experience with

qualitative research. Also, a special education teacher helped the researcher throughout the research.

Prolonged engagement is about spending considerable time learning about the culture, building trust, and identifying misinformation by the self or the respondents (Lincoln & Guba, 1985). Creswell and Creswell (2018) explained that the time the researcher spends with the subjects in their settings is likely to end up with more valid findings (Yıldırım & Şimşek, 2016). In this study, the researcher spent more than one month in the special education and rehabilitation center with LD students. She had the chance to interact with and observe more students than the sample size. The researcher also had the opportunity to communicate with teachers and learn more about the students, their learning process, how these centers implement special education, and their needs. In other words, the researcher had time to learn the culture closely and establish more intimate relationships with students and teachers.

3.7.2 Transferability

Transferability, external validity, is about the generalization of the research results. Although generalization in qualitative research cannot be recognized statistically as in quantitative studies, four strategies often ensure transferability in qualitative research: thick-rich description, sampling within, multi-site design, and modal comparison (Merriam, 2009). The current study used thick-rich description to enhance transferability.

Thick-rich description is used to describe the research setting in detail (Creswell & Miller, 2000). According to Creswell and Creswell (2018), if a researcher provides a rich and detailed description of the settings, the results of qualitative research would be prosperous and more realistic (Creswell, 2017). Moreover, it helps readers imagine the data collection environment and understand the process of data collection and analysis; therefore, they may conveniently transfer the knowledge into their studies (Yıldırım & Şimşek, 2016). In the current study, the research design, the procedures of design & development of the online learning material, methodology, and findings were explained in detail for the consideration of prospective researchers.

3.7.3 Dependability

Dependability, reliability in quantitative research, is about the replicability and consistency of the research results. In qualitative studies, reliability is problematic, and replicability may not be possible because human behavior is not static, and the events and phenomena are constantly changing, yielding differences in the nature of reality (Merriam, 2009; Yıldırım & Şimşek, 2016). According to Lincoln and Guba (1985), there are strategies to enhance dependability in qualitative research: intercoder agreement and audit trail, among which the current study resorted to the first.

Intercoder agreement is a strategy to ensure dependability. It is a process of involving (an)other coder(s) to agree on the codes and aims to determine whether the coder(s) would code the same data with similar codes or not (Creswell & Creswell, 2018). An academic, a colleague of the researcher with substantial experience with qualitative research, assisted the present study in ensuring intercoder reliability of the interviews based on a reliability coefficient formula proposed by Miles and Huberman (1994).

3.7.4 Confirmability

Confirmability refers to objectivity in quantitative research. In general, research findings are expected to be free of the researcher(s)'s subjective judgments and assumptions. However, it is assumed that it may not be possible to yield complete objectivity and no researcher bias in qualitative research (Yıldırım & Şimşek, 2016); thus, Lincoln and Guba (1985) offered *reflexivity* to ensure confirmability.

Reflexivity is one of the prominent characteristics of qualitative research (Creswell & Creswell, 2018). It is a procedure for researchers to explain their assumptions, biases, and beliefs. In qualitative research, it is also essential to let readers understand the researcher(s)' role and position; therefore, a detailed researcher's role is suggested in the research (Creswell & Miller, 2000; Merriam, 2009). The current study presents a detailed role of the researcher to ensure confirmability.

3.8 Researcher's Role

The researcher assumed an active role throughout the whole study. First, she conducted an in-depth needs analysis through a series of interviews with research stakeholders - teachers and academics - in their own settings. Secondly, although there was a development team helping the researcher to develop the online learning material, she was rather more active in the design and development cycles. She held meetings with experts and took notes on the design of the material. Then, she explained to the team what they would do throughout the research and repeatedly tested their work. She also assisted the team when confronting technical problems. In addition, she observed the experts and students as many times as possible while they were engaged in the online learning material without any comments not to affect them; the aim was to determine their interactions with the online learning material.

Lastly, the researcher also spent considerable time in the school of LD students in the implementation & evaluation phase. She was allocated a classroom like other teachers. The researcher had the chance to participate in school life and observed the teachers and students in their natural settings, helping her be part of the school community; thus, the students did not develop a sense that they were observed and tested.

CHAPTER 4

RESULTS

This chapter presents the results for each research question by combining the findings from analysis, design & and development and implementation & evaluation phases and different data collection tools such as interview protocol, observation forms and notes, expert opinions and achievement tests.

4.1   Findings on the Design Principles

RQ1: What are the design principles for developing an online learning material to support the reading comprehension of students with Learning Difficulties (LD) in an expository text through teaching technical vocabulary?

The researcher primarily and utmostly sought an answer to this question through the findings from the analysis, design & development and implementation & evaluation phases. Table 7 shows the themes, categories and subcategories emerging for the question 1. There are two main themes "principles for selecting content" and "priniciples for instructional design". Each theme has its own categories and subcategories. The below section presents findings for each phase by providing occurred themes, categories and subcategories.

Table 7. Themes, categories and subcategories emerged for the RQ1

Themes / Categories / Subcategories
Principles for selecting content
1. Teaching Vocabulary
a. Importance of vocabulary
b. Using visuals
c. Using videos
d. Using the word in a sentence
e. Providing simple definition
f. Using a text covering the words taught
2. Texts
a. Texts
b. Words
c. Text type
d. Restrict unknown words in the text

Table 7 cont. Themes, categories and subcategories emerged for the RQ1

Themes / Categories / Subcategories

Principles for instructional design

1. Multisensory material
    a. Using visuals
        i.   Using big and clear visuals
        ii.   Using real/daily-life realted visuals
        iii. Using real photos
        iv.   Support visuals with text
        v.   Providing examples/non-examples
    b. Using video / animation
        i.   Using videos /animations focused on what to teach
    c. Using audio
        i.   Emphasized voice
        ii.   Non-mechanical voice
2. Instruction
    a. Giving instructions to students about what to do
    b. Short, clear and stepwise instructions
3. Highlighting
    a. Highlighting target information
    b. Highlighting the selection area
4. Interface design
    a. Simple design
    b. Contrasting colors
    c. Soft background colors
    d. Font type/size
    e. Providing information abou the buttons used
    f. Scrollbar
    g. Consistency
5. Practice
    a. Importance of providing practice
    b. Provide more interaction than text
    c. Presenting information cumulatively
    d. Offering a chance to revisit th subject area
    e. Going back to last screen after revisiting the subject area
    f. Simple to complex structure
6. Feedback
    a. Importance of providing feedback
    b. Offering immediate feedback
    c. Giving students a chance to review the questions and their answers
    d. Designing feedback keeping the flow of the practice
    e. Using appropriate visuals for the feedback
    f. Using appropriate tone for the feedback
    g. Providing results as a graphic
    h. Providing transition screens

4.1.1 Findings of the Analysis Phase

The researcher interviewed seven special education teachers and four academics in the analysis phase to learn their initial recommendations for designing and developing an online learning material to support students' reading comprehension in an expository text through teaching vocabulary. The initial findings revealed two main themes: principles for selecting content, and principles for instructional design (see Table 8).

Table 8. Initial themes emerging in the analysis phase

Main Themes
Principles for selecting content
Principles for instructional design

4.1.1.1 Principles for Selecting Content

Principles for selecting content is the third theme emerging in the analysis phase and has two main categories: teaching vocabulary and texts.

Table 9. Categories of the theme principles for selecting content

Category
1. Teaching Vocabulary
2. Texts

4.1.1.1.1 Teaching Vocabulary

Teaching vocabulary is the first category of theme principles for selecting content and touches upon how to teach vocabulary. Moreover, it was divided into six sub-categories (Table 10).

Table 10. Sub-categories of the category teaching vocabulary

Sub-category	N
a. Importance of vocabulary	5
b. Using visuals	6
c. Using videos	2
d. Using the word in a sentence	5
e. Providing simple definition	5
f. Using a text covering the words	4

a. Importance of Vocabulary

In the analysis phase, five of the participants emphasized the importance of vocabulary for the reading comprehension skill. They expressed their opinions by saying:

Vocabulary knowledge is essential for reading comprehension... (SET2).
Kelime hazinesi ve kelime bilgisi çok önemli okuduğunu anlamada ... (SET2).

There are many reasons for having difficulty in comprehension. I think the most important reason is not to have a broad lexical capacity... For example, if the text contains many unknown words, the child may not understand it... That is why vocabulary is so crucial (SET5).
Onun [okuduğunu anlamada güçlük çekmenin] birçok nedeni var. Bence en önemli nedenlerinden biri sözcük dağarcığının çok dar olması ... Metinde birçok mesela anlamını bilmediği sözcük oldu mu o hava da kalıyor... O yüzden hani sözcük dağarcığının gelişmesi daha önemli (SET5).

Well, many reading comprehension problems are derived from a lack of prior knowledge. It can be related to vocabulary ... It is not easy to expect a child to understand a text covering words they do not know the meaning of (A3).
Yani okuduğunu anlama problemlerinin önemli bir kısmı da ön bilgi eksikliğinden kaynaklanıyor... Ön bilgi, bu kelime bilgisi de olabilir... Çocuğun çok fazla anlamını bilmediği kelime içeren bir metni anlamasını beklemek çok zordur (A3).

In the literature, both experimental and descriptive studies show that vocabulary directly affects reading comprehension. (A4).
Şimdi alan yazında baktığımız zaman hem deneysel çalışmalara hem betimsel çalışmalara, kelime bilgisinin öğrencilerin okuduğu metinler üzerinde metinleri anlamaları üzerinde etkileri olduğunu doğrudan etkileri olduğunu görüyoruz. (A4).

b. Using Visuals

Design Principle: "The vocabulary teaching should be promoted with visuals."

According to the findings of the analysis phase, six participants explained that vocabulary teaching should be promoted with visuals:

One needs to support teaching vocabulary with lots of visuals (SET1).
Kelime öğretimi yaparken bol bol görsellerle desteklemeniz gerekiyor (SET1).

Let's pretend that the student did not know the word "board." If I cannot help students understand the word by explaining it, I try to visualize it. I show the board itself or its picture from my tablet (SET2).
Örnek veriyorum işte tahta. [Öğrencinin] Bunun anlamını bilmediğini varsayalım. Anlatarak eğer bunu çözemiyorsak bunu görselleştiriyorum. Tahtayı çıkartıyorum gösteriyorum ya da ne bileyim tabletten [kendi tabletinden] işte resmini gösteriyorum (SET2).

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Since we have phones, we look for visuals from Google related to the word that we intend to teach (SET7).
Yani artık elimizin altında telefon olduğu için hemen bir görsellerine bakıyoruz şeyden Google'dan (SET7).

You definitely need to visualize the word (A3).
[Kelimeyi] Görselleştirmek lazım kesinlikle (A3).

c. Using Videos

Design Principle: "The vocabulary teaching should be supported with videos."

The findings indicated that videos should be used to promote vocabulary teaching:

If I am going to teach vocabulary, there should be images, sentences, and videos, especially videos related to the word if available (SET1).
Kelime öğretimi yapacaksam özellikle o kelimeyle ilgili görseller, cümleler, video bulunabiliyorsa özellikle video [olması gerekiyor] (SET1).

We show videos about the word to the children. (A4)
Bu kelimeyle ilgili videolar çocuklara izletiyoruz. (A4)

d. Using the Word in a Sentence

Design Principle: "The word to be taught should be used in a sentence to promote vocabulary teaching."

In the analysis phase, five participants claimed that the word to be taught should be used in a sentence:

It is necessary to teach vocabulary with visuals, texts, and sentences (SET1).
Görseller artı yazılı belgeler ya da yazılı metinler, cümleler şeklinde destekleyip bunun üzerine bir kelime öğretimi yapmanız gerekiyor. (SET1)

I think the word should be used in a sentence (SET5).
*Bence öncesinde kelimenin ... cümle içerisinde kullanılması [gerekir] (*SET5).

The teacher has the child use the word in different sentences, or the teacher can use the word in different sentences to clarify it (A3).
[Çocuğun] sözcüğü farklı cümleler içeresinde kullanması sağlanabilir ya da öğretmen farklı sözcükler farklı cümleler içerisinde kullanarak çocukların kafasında netleştirmesini sağlayabilir (A3).

e. Providing a Simple Definition of the Word

Design Principle: "A simple definition of the word should be provided while teaching vocabulary."

Five participants argued that a simple definition of the word should be provided while teaching vocabulary:

> *Considering it step by step, I think a simple definition of the word should be provided first* (SET5).
> *Basamak basamak eğer derecelendirirsek benim görüşümce ilk olarak anlamı, hani ne alama geldiği, tabi basit bir ifade ile [verilmeli]* (SET5).
>
> *In fact, a dictionary is used a lot...For example, the word "orak" is collocated with the words flat, harvest, and so on. In other words, the word is already defined with many unknown words, so students do not understand it since they do not know other words in the definition* (A2).
> *Aslında sözlük kullandırma çok yapılıyor... Örneğin; "orak" kelimesini tanımlıyor sözlük ama işte yassı, ekin biçme bilmem ne diye o kadar bilinmedik kelimeler ile tanımlıyor ki çocuk orada okuduğunu o terimleri de bilmediği için tanımı anlamıyor* (A2).
>
> *Instead of a dictionary definition, there should be a functional definition for the word... A simple definition that the student can understand...* (A3)
> *Bir sözlük tanımı yerine işlevsel bir tanım koymak lazım o sözcükle ilgili... Çocuğun anlayabileceği daha basit bir tanım yani* (A3).

f. Using a Text Covering the Words Taught

Design Principle: "A text covering the words to be taught should be provided to promote vocabulary teaching."

Four participants argued that vocabulary teaching should be supported with a text. In other words, students should see the words they would learn in a text:

> *If I am going to teach a word, there should be many texts related to the word* (SET1).
> *Kelime öğretimi yapacaksam özellikle o kelimeyle ilgili ...bol bol o kelimeyle ilgili yazılmış metinlerin olması gerekiyor aslında.* (SET1)
>
> *Let's say, I would teach vocabulary... I would put reading texts covering those words... It would be significant to have texts including the words to be taught* (SET2).
> *Örnek veriyorum işte kelime öğretiyorsunuz... Bu kelimelerin barındığı okuma metinleri koyardım... [Öğretilen] kelimeleri barındıran metinlerin olması gerçekten çok önemli olur* (SET2).

I provide the students with different texts covering the word and ask them to catch up on the meaning of the words from the texts (SET4).
O kelimenin geçtiği farklı farklı yerleri vs. vererek, onlara sence burada ne demek istemiş vs. kullanım yerleri verip, bağlam içinde anlam çıkarttırmaya çalışıyorum. Bunlar için farklı metinler seçiyorum. (SET4)

4.1.1.1.2 Texts

The "texts" is the second category of the theme principles for selecting content and has four sub-categories (Table 11).

Table 11. Sub-categories of the category texts

Sub-category	n
a. Texts	5
b. Words	4
c. Text type	3
d. Restricted unknown words in the text	2

a. Texts

Design Principle: "The texts to be used in the material should be appropriate for the grade level."

Five participants explained that the texts to be used in the material should be appropriate for the grade level:

> *The selection of texts should consider the student's level.* (SET3).
> *[Metinlerin seçimi] Çocukların düzeyine göre [olmalı].* (SET3)

> *It can be grouped according to grade level. For example, grade levels 1, 2, 3, 4, and 5… If one assigns a fourth-grade level text to a first-grader, the child does not understand it.* (SET7).
> *Sınıf olarak gruplandırılabilir. Yani 1. Sınıf seviyesi, 2. Sınıf, 3., 4., 5. Sınıf seviyesi. Çünkü 1. Sınıf seviyesindeki çocuğa 4. Sınıf seviyesi verirseniz anlayamaz.* (SET7).

> *For the content aspect, as I said, the text's readability, which is appropriateness for the child's age and grade level, should be considered* (A2).
> *İçerikte de dediğim gibi metnin okunabilirlik yani daha doğrusu yaşına uygunluğunu, sınıf düzeyine uygunluğunun belirlenmiş olması gerekir* (A2).

b. Words

Design Principle: "The words to be taught should be appropriate for the grade level."

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Four participants explained that the selected words should be appropriate for the grade level:

> *I especially teach daily life words that they do not know their meanings. Also, I work on the words in reading comprehension texts of their grade levels or one grade below (SET2).*
> *Hani günlük yaşamda kullandığı ancak anlamını bilmediği ya da kendi sınıf düzeyinden ya da bir sınıf aşağısından okuduğu, okuduğunu anlama metinlerinde bilmediği kelimelerin anlamlarını özellikle çalıştırıyorum (SET2).*
>
> *It is important to have words appropriate for children's grade level. (A3).*
> *Şimdi şey çocukların bir kere bulunduğu sınıf düzeyine uygun sözcükler olması önemli. (A3).*

c. Text Type

The findings highlighted the importance of the text type. Three participants agreed on the importance of text type and disclosed their thoughts as follows:

> *Understanding expository texts is more complicated than narrative texts because of the concepts and words they cover (A1).*
> *Bilgilendirici metinleri anlamak öyküleyici metinleri anlamaktan zordur. Bunu nedeni [metnin] içindeki kavramlardan kelimelerden kaynaklanır (A1).*
>
> *When comparing expository texts and narrative texts, children have fewer problems while understanding the narrative texts. (A2).*
> *Tabi ama öyküleyici metinlerle ile bilgi veren metinleri karşılaştırdığımız zaman öyküleyici metinleri anlamakta daha az problem yaşıyor bu çocuklar. (A2).*
>
> *Children with learning disabilities or reading difficulties need vocabulary knowledge more, especially in expository texts (A3).*
> *Yani özellikle bilgi verici metinlerde bilinmeyen kavramlar işin içerisine girdiğinde öğrenme güçlüğü olan çocuklar ya da okuma güçlüğü olan çocuklar bu noktada kelime hazinesinin etkisine daha çok ihtiyaç duyuyorlar (A3).*

d. Restricted Unknown Words in the Text

Design Principle: "The unknown words in the text should be restricted."

Participants asserted that unknown words in a text should be limited. Two of the participants clarified by saying:

> *... A few words related to each other or the things sharing the same context can be taught in the same text. However, there should be certain restrictions. (SET1).*

... Hani birbiriyle ilişkili birkaç kelimenin öğretimi aynı metin içerisinde yapılabilir. Ya da bağlamları aynı şeyleri aynı metnin içerisinde belki öğretebiliriz ama bununda belli bir sınır olmalı diye düşünüyorum. (SET1).

Yes, texts may include words the child does not know. However, we restrict them in a way that the child can extract the meaning of the word from the context, enjoy reading the text, and have a sense of achievement (A3).
Evet, çocuğun anlamını bilmediği sözcükler içerir metin ama onları sınırlı tutarız ki çocuk hem o sözcüğün anlamını belki metin içerisindeki bağlamdan çıkarabilir, hem o metni okurken keyif alabilir, hem de bir başarı duygusunu elde etmiş olabilir (A3).

4.1.1.2 Principles for Instructional Design

The last theme emerging in the analysis was principles for instructional design and evaluated within seven categories (Table 12).

Table 12. Categories of the theme principles for instructional design

Category
1. Multisensory Material
2. Instruction
3. Highlighting
4. Interface Design
5. Practice
6. Feedback

4.1.1.2.1 Multisensory Material

Design Principle: "The material should appeal to multiple senses."

It is the first category of the theme principles for instructional design and has three sub-categories: using visuals, using videos/animations, and using audio (Table 13).

Table 13. Sub-categories of the category multisensory material

Sub-category	n
a. Using Visuals	7
i. Using real photos	4
ii. Using big and clear visuals	3
iii. Using real/daily-life visuals	2
b. Using videos/animations	1
c. Using Audio	4
i. Emphasized Voice	1

Four of the participants asserted their opinions about multisensory material as follows:

> *For example, does the child catch it more quickly when they hear a sound or see a visual? .... However, I think using both visuals and sound increase the chance of learning* (SET1).
> *Mesela ses duyduğunda mı daha çabuk kapabiliyor ya da görsel gördüğünde mi? ... Ama ikisinin birleştirilmesi bence o öğrenme oranını öğrenme şansını daha da arttırır diye düşünüyorum* (SET1).

> *The material covering both visuals and sound can be prepared* (SET3).
> *Hem görsel hem sesli olabilecek bir materyal işte hazırlanabilir.* (SET3)

> *Well, I think using technology-based material would be very beneficial because the more senses it appeals to, the more permanence the learning achieves* (SET4).
> *Yani evet bunun [teknoloji tabanlı materyal] kullanımının çok yararlı ve faydalı olabileceğini düşünüyorum. Çünkü ne kadar çok duyuya hitap edersek o kadar çok kalıcılık artıyor.* (SET4)

> *I think materials should provide students with much more stimuli and related components... In other words, different components should activate students' prior vocabulary knowledge* (A4).
> *Materyalin çok daha fazla uyarana, çok daha fazla ilgili bileşene doğru çocuğu götürmesi gerektiğini düşünüyorum... Bu kelime olayında çocukların ön bilgisini harekete geçirecek birkaç tane daha farklı farklı bileşenin orada olması gerektiğini düşünüyorum* (A4).

a. Using visuals

The findings implied that vocabulary teaching should be supported with visuals. Using visuals is the first sub-category of the category multisensory material and has three codes: using real photos, big and clear visuals, and real-life/daily-life visuals.

i. Using real photos

Design Principle: "The visuals to be used in the material should be real."

Four participants argued that the visuals to be used in the material should be real:

> *The child can relate very well when seeing an exact photo of something in real life.* (SET3).
> *Gerçek hayatta gördüğü bir şeyin tam fotoğrafını gördüğü zaman çocuk çok güzel bağdaştırabiliyor* (SET3).

It depends on age, but I find real photos more appropriate. It is important for a child to think that it is something from their life, observed in the environment, and offers something of themselves (SET4).

Yaş seviyesine göre çok değişir ama gerçek fotoğrafları daha uygun buluyorum. Çevrede gözlemlediği, bunun hayatından bir şey olduğunu ve bunu okuduğunda kendinden bir şeyler bulabileceğini düşünmesi önemli. (SET4)

I generally use pictures from books, but photos make more sense (SET6).
Genelde kitaplardaki resimleri kullanıyorum ama gerçeği daha mantıklı olur (SET6).

ii. Using big and clear visuals

Design Principle: "The visuals to be used in the material should be big and clear enough to understand the target word easily."

Three participants claimed the visuals to be used in the material should be big and clear enough to understand the target word easily:

... However, one should determine whether they understand the visual before using it ... Photos may not be clear about what they want to tell (SET5).
... Ama öncesinde sizde buna [görsele] bir kendinizi oraya koyarak [bakın]. Hani ben bundan anlayabiliyor muyum? ... Bazen fotoğraflar tam olarak yansıtmıyor (SET5).

However, I know that visuals should be clear ... There should not be unclear visuals. They should be vivid and clear visuals of what is being conveyed (A2).
Ama şunu biliyorum ki net resimler olmalı ... Ne olduğu anlaşılmayan resimler olmamalı. Canlı, net, ne anlatmak istediğini belirten görseller olmalı bunlar (A2).

Metin is working with his computer. Here, it should not exactly be an Office image but rather a male figure in front of the computer... It can be important to have a visual that keeps the background simpler and focuses directly on the word to be taught (A3).
Metin bey bilgisayarıyla çalışıyor. Burada tamamen bir ofis görüntüsü değil de hani bilgisayarın önünde bir erkek figürü gibi... Hani arka planı daha sade tutup doğrudan söz konusu sözcüğe odaklanacak şekilde bir görsel olması önemli olabilir (A3).

iii. Using real/daily-life visuals

Design Principle: "The visuals to be used in the material should be based on real/daily life."

In the analysis phase, two interviewees argued that the visuals to be used in the material should rely on real /daily life:

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The child can relate very well when seeing an exact photo of something in real life. Sometimes children cannot fully understand the subject since they cannot reconcile it (SET3).

Gerçek hayatta gördüğü bir şeyin tam fotoğrafını gördüğü zaman çocuk [onları] çok güzel bağdaştırabiliyor. Bazı çocuklar o ikisini bağdaştıramadığı için tam algılayamıyorlar (SET3).

It depends on age, but I find real photos more appropriate. It is important for a child to think that it is something from their life, observed in the environment, and offers something of themselves (SET4).

Yaş seviyesine göre çok değişir ama gerçek fotoğrafları daha uygun buluyorum. Çevrede gözlemlediği, bunun hayatından bir şey olduğunu ve bunu okuduğunda kendinden bir şeyler bulabileceğini düşünmesi önemli (SET4).

b. Using videos/animations

Design Principle: "The vocabulary teaching should be supported with videos."

The findings indicated that videos should be used to promote vocabulary teaching:

If I am going to teach vocabulary, there should be images, sentences, and videos, especially videos related to the word if available (SET1).

Kelime öğretimi yapacaksam özellikle o kelimeyle ilgili görseller, cümleler, video bulunabiliyorsa özellikle video [olması gerekiyor] (SET1).

We show videos about the word to the children (A4).

Bu kelimeyle ilgili videolar çocuklara izletiyoruz (A4).

c. Using audio

Design Principle: "The vocabulary teaching should be supported with audio."

Four participants emphasized using audio to promote teaching the word:

Exactly… The child should hear how the word is pronounced (SET3).

Aynen işte o kelime nasıl ifade ediliyor. Çocuk onu da bir yerde duymalı (SET3).

If there is a vocalization, the children can notice how to pronounce or pause at a comma/a dot, which affects them while reading… The dots and commas also promote understanding. Therefore, vocalization can be better (SET4).

[Seslendirme olursa] Doğru telaffuzu, nasıl okuması gerektiğini, ya da işte virgülde, noktada duraksadığını filan fark edebilir… Aslında noktalar, virgüllere bakınca anlama yükseliyor. O yüzden seslendirme o açıdan çok iyi olabilir (SET4).

The pronunciation of the word can also be given… Sound is important… Some of our children do not know how to read yet, or they understand better audibly (SET5).

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Kelimenin telaffuzu da verilebilir…. İllaki. Ses önemli…Bazı çocuklarımız daha okumayı tam olarak bilmiyor veya işitsel olarak şey yapıyor [daha iyi anlıyor] (SET5).

i. Emphasized voice

Design Principle: "The audio to be used in the material should include a rising/falling intonation."

One of the participants interviewed reported using intonation while pronouncing the word and the sentence in the text:

> *While pronouncing the word, I use intonation… Then, children understand the word better* (SET3).
> *İşte söylerken vurgulayarak söylüyorum işte… O zaman çocuklar daha güzel anlıyorlar* (SET3).

4.1.1.2.2 Instruction

"Instruction" is the second category of the theme principles for instructional design and evaluated within two sub-categories: "Giving instructions to students about what to do" and "short, clear, and stepwise instructions."

a. Giving instructions to students about what to do

Design Principle: "The material should provide instructions to tell students what to do."

The results of the analysis phase highlighted using instructions in the material to inform students about what to do. The participants reported their opinions as follows:

> *A voice can be used to give instructions to remind the child where to touch when touching the wrong place.* (SET1).
> *… Yanlış yere dokunduğunda nereye dokunması gerektiğiyle ilgili tekrar yönerge verecek bir ses kullanılabilir.* (SET1).
>
> *It may be important to … provide instructions. It is important to remind the child where to click* (A3).
> *Şimdi bir kere şey hani ara yüzün şey olması çok önemli… Yönerge veren şekilde işte şimdi buraya bas gibi diye hani şekilde kullanılması önemli* (A3).

b. Short, clear, and stepwise instructions

Design Principle: "The instructions to be given in the material should be short, clear, and stepwise."

According to the findings, two participants believed that the instructions should be short, clear, and stepwise:

> *We favor clear instructions because they should include clear, short, and brief information to direct students to the part to be focused on. For example, instructions can be provided stepwise* (SET3).
> *Yönergelerin net olmasından yanayız çünkü odaklanması gereken yere odaklayacak net, kısa özet bilgiler içermesi lazım. Mesela yönergeler madde madde olabilir* (SET3).

> *We do not use two instructions in one sentence. We recommend giving one instruction at a time…. Instructions should also be clear and short. They should be stepwise, too* (A2).
> *Biz şimdi ikili yönergeyi bir cümle içinde zaten kullanmıyoruz. Biz tek yönerge öneriyoruz… Bir de yönergeler net ve kısa olmalı. Adım adım olacak* (A2).

4.1.1.2.3 Highlighting

Highlighting is the third category of the theme principles for instructional design and evaluated within a sub-category: highlighting target information.

a. Highlighting target information

Design Principle: "The material should highlight the information/words to be taught."

The results revealed that information or words to be focused on should be highlighted:

> *Coloring the target information attracts more attention* (SET3).
> *Odaklanılacak şeyin renkli olması daha çok dikkat çekiyor* (SET3).

> *The word can be emphasized with a brighter color...* (A3)
> *Bir de şey hani söz konusu sözcüğü vurgulamak belki daha parlak bir renk ile. ...* (A3)

> *It can be good to write the target word in a different color* (A1).
> *Öğreneceği kelimeyi farklı bir renkte yazmak güzel olabilir* (A1).

4.1.1.2.4 Interface Design

Interface design is the fourth category of the theme principles for instructional design and evaluated within six sub-categories, as in the table below. The sub-categories are all related to font type/size, colors, simple design, and buttons (Table 14).

Table 14. Sub-categories of the category instructional design

Sub-category	n
a. Font type/size	5
b. Simple design	3
c. Contrasting colors	3
d. Soft background colors	2
e. Providing information about the buttons	2

a. Font size/type

Design Principle: "The material should allow students to customize font size/type for themselves."

The findings of the analysis phase revealed that allowing customizing font type and size matters for LD students. Participants explained that font type and size should be appropriate for students:

> *…The only problem is that every child is diverse and individualistic, which makes things mixed up… Students can choose the appropriate font size for themselves* (SET3).
> *… Biz de tek sıkıntı şu; her çocuk çok farklı ve çok bireysel ya o yüzden çok karışıyor… Puntoyu kendi seçebilmesi makul* (SET3).
>
> *Font size should be appropriate for students because they have individual differences* (SET7).
> *Yazıların puntosu öğrenciye uygun olmalı ama öğrencilerde de yine bireysel farklılıklar var.* (SET7)

b. Simple design

Design Principle: "The material should have a simple design."

In the findings, three participants highlighted the importance of simple design in the material:

We considered distractors while designing the material. Its interface was straightforward, but it was interesting as well (SET2).
Yani dikkat dağıtıcı unsurları bir defa göz önünde bulundurduk onu [materyali] tasarlarken. Hani ara yüzler falan çok sade oldu ama bir o kadar da ilgi çekici oldu öyle söyleyeyim (SET2).

The material should be easy to use. I mean, there should not be so many buttons to click on. Something simpler to use... (A2)
Kolay kullanılabilir olmalı. Yani birçok tıklanacak bir şey değil de ... Biraz böyle daha basit kullanımlı... (A2)

It is imperative to have a simple interface (A3).
Şimdi bir kere şey, hani ara yüzün şey olması çok önemli. Basit kullanılabilir (A3).

c. Contrasting colors

Design Principle: "The material should be designed with contrasting colors."

Three participants emphasized using contrasting colors while designing the material design:

... using a red object over a red background will be hard to notice. So, the background-surface interaction needs to be considered (SET4).
... çünkü aynı renkleri atıyorum ıı kırmızı zemin üzerine kırmızı bir nesne verirseniz illaki onu şeyi [fark etmek] olur. O yüzden zemin yüzey ilişkisine dikkat ederseniz daha iyi olur (SET4).

Having contrasting colors is important. It is necessary to pay attention to softer background colors and darker visual colors (A3).
Renkler anlamında kontrast renkler olması önemli... O anlamda kontrast renklere yer vermek işte tabanın daha açık renkte olup görsellerin koyu renkte olması gibi şeylere dikkat etmek lazım tabi (A3).

d. Soft background colors

Design Principle: "Soft background colors should be used while designing the material."

According to the results, two participants highlighted using soft background colors in the material design:

The page color is important. Some children can read easily over the cream-colored page, while others prefer a white screen (A1).
Sayfanın rengi çok önemli. Bazı çocuklar krem rengi sayfada çok rahat okuyabiliyorlar. Bazı çocuklar beyaz ekranda daha rahat okuyabiliyorlar (A1).

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e. Providing information about the buttons

Design Principle: "The material should provide information about the buttons used in the material."

Providing information about the buttons is the last sub-category of the category interface design. Two of the participants explained that the functions of the buttons should be provided in the material:

> *Signs to be used should be explained under the page or somewhere else.* (SET1).
> *Kullanması gereken işaretlerin anlamları sayfanın altında ya da herhangi bir yerinde verilebilir.* (SET1)

> *It writes "pass" on the button. Is it enough? No. I think there should be an arrow. The child must pass the other screen when clicking on the arrow. However, there should be a text under it saying "pass."* (SET2).
> *İşte geç butonu tamam geç yazıyor burada. Sadece yeterli mi? Hayır. Bir ok koyulması gerektiğini düşünüyorum. Ok'a bastığında geçsin. Altında geç yazabilir.* (SET2).

4.1.1.2.5 Practice

Practice is the fifth category of the theme principles for instructional design and addressed within a sub-category: providing practice.

a. Importance of providing practice

Design Principle: "The material should provide a chance to practice target words."

Three participants agreed that the material should provide a chance to practice target words:

> *The vocabulary teaching should be something that can be repeated over and over again ... Uttering "telescope" once does not make sense. Therefore, the word should not be bound to the day it has been taught and should be practiced* (A2).
> *Bir de kelime öğretiminin sürekli tekrarlanabilir bir şey olması lazım ... Siz zaten bir gün bir teleskop dediniz bunun kelime hazinesine zaten oradan girmeyeceği belli bir şey. O yüzden sözcük öğretildiği günde, saatte ve dakika da kalmamalı ve tekrar edebileceği şeyler yapılmalı* (A2).

> *This program should be designed to allow the child to repeat target words from time to time.* (A3).
> *Çocuğun oradan zaman zaman tekrarlar yapmasına olanak verecek şekilde bu program belki yapılmalı.* (A3)

4.1.1.2.6 Feedback

The category feedback is the last category of the theme principles for instructional design. It has two sub-categories: importance of providing feedback and appropriate tone for the feedback.

a. Importance of providing feedback

Design Principle: "The material should provide feedback."

The importance of the feedback is the first sub-category of the category feedback. Two of the participants highlighted the importance of providing feedback:

> *If I teach vocabulary, then I will provide feedback on the words* (SET2).
> *Örnek veriyorum işte kelime öğretiyorsunuz. Bu kelimelerle ilgili geri dönütler yapılmasını sağlardım* (SET2).
>
> *The feedback is critical… Therefore, I think that immediate feedback… is significant* (SET4).
> *Dönüt çok önemli gerçekten mesela… O yüzden dönütün... anında verilen şeylerin çok önemli olduğunu düşünüyorum.* (SET4)

b. Appropriate tone for the feedback

Design Principle: "An appropriate tone for the feedback should be considered in the material."

In the analysis phase, one of the participants explained that an appropriate tone should be used while providing feedback:

> *We provide feedback reinforcing correct answers. For wrong answers, we use softer feedback like "Let's try again" instead of "Your answer is totally wrong"* (SET2).
> *İşte doğru cevapları motive edecek şekilde dönütlerin ama yanlış cevabı işte yanlış yaptın değil tekrar deneyelim şeklinde, hani böyle yumuşatılmış.* (SET2)

4.1.2 Findings of the Design and Development Phase

The design & development phase consisted of four cycles with the special education teachers, academics, and LD students. These cycles were named Design 1, Design 2, Design 3, and Pilot (see Figure 1). In this phase, expert opinions and observations were adopted as data collection tools used. Three special education teachers, three

academics from special education, and two LD students contributed to the design &
development phase. The findings of each design and development cycle are presented
below.

4.1.2.1 Design 1 – First Design and Development Cycle

The findings of the first design and development cycle revealed principles for the
theme (i.e., principles for instructional design explained in the analysis phase). Table
15 presents the categories of this theme.

Table 15. Categories of the theme principles of instructional design

Category
1. Multisensory Material
2. Instruction
3. Highlighting
4. Interface Design
5. Practice
6. Feedback

4.1.2.1.1 Principles for Instructional Design

4.1.2.1.1.1 Multisensory Material

Multisensory material is the first category of the theme principles of instructional
design. The sub-categories/codes of this category are shown in Table 16.

Table 16. Sub-categories of the category multisensory material

Sub-category	#Freq
a. Using Visuals	2
i. Using real/daily-life visuals	3
b. Using big and clear visuals	3
c. Supporting visuals with texts	3
d. Providing examples/non-examples	1
b. Using videos/animations	
i. Using videos/animations about what to teach	1
c. Using Audio	
i. Emphasized voice	1
ii. Non-mechanical voice	1

a. Using visuals

Design Principle: "The vocabulary teaching should be supported with visuals."

In addition to the analysis phase findings, two participants in Design 1 also highlighted the importance of using visuals in vocabulary teaching:

> *In order for words to be acquired better, they should be supported by visuals* (A5).
> *Kelimelerin daha iyi anlaşabilmesi için görsellerle desteklenmesi lazım.* (A5)

> *One's job would be much easier if supporting the target word with visuals* (A6).
> *Görsellerle destekleseniz [kelimeyi] işiniz tabi ki daha kolay olur* (A6).

i. Using real/daily-life visuals

Design Principle: "The visuals to be used in the material should be real/daily-life oriented."

In Design 1, experts also claimed that the visuals to be used in the material should be real/daily-life oriented:

> *Children may not know silver or gold as bullion. They may know them in the form of their mothers' jewelry* (A5).
> *Gümüşü ya da altını çocuklar külçe olarak bilmez. Annesinin taktığı gümüş ya da altın olarak bilirler* (A5).

> *How many children with learning difficulties have seen gold bullion?... It is necessary to think of gold varieties that they may be more familiar with... Daily life examples make one's job easier* (A6).
> *Kaç tane öğrenme güçlüğü olan çocuk külçe altın görmüştür... Daha aşina olabileceği altın çeşitlerinden düşünmek lazım hocam... Daha gündelik hayattan örnekler sanki işinizi daha kolaylaştırır* (A6).

ii. Using big and clear visuals

Design Principle: "The visuals to be used in the material should be big and clear enough to understand the target word easily."

The findings of Design 1 showed that the visuals to be used in the material should be big and clear enough to comprehend the word easily. Three of the participants explained their thoughts as follows:

The silver and gold pictures should get bigger so children can perceive the details. Please, consider those who wear glasses too... Let it be a visual that can be understood at first glance (A5).

Gümüş, tuz ve altın görüntüleri biraz daha büyüsün. Çocuk görseldeki detayı algılayabilsin. Gözlük kullanan çocukları da düşün... İlk bakışta o olduğu [anlatmak istediğimiz kelime] anlaşılabilecek şekilde olsun görsel (A5).

You have tried to support the word with visuals of silver, gold, and salt. However, I do not think children will understand the picture of salt.... It may be confused with sugar. (A6).

Gümüş, tuz, altın bunu [kelimeyi] resimlerle desteklemeye çalışmışsınız. Ama mesela ben tuz resmini buradan çocuğun tuz resmini ben buradan anlayacağını düşünmüyorum... Mesela bunu şeker de anlayabilir hocam. (A6).

I had difficulty understanding the salt spilling in the picture because the spoon is black, and the background is white. I could not understand that salt spills from the spoon (SET1).

Mesela orada tuz döküldüğünü anlamakta biraz zorlandım ben. Çünkü kaşık çok siyah olmuş ve arka plan da beyaz kaldığı için ben orada kaşığın içinden tuz döküldüğünü anlayamıyorum (SET1).

iii. Supporting visuals with texts

Design Principle: "The visuals should be supported with a text to promote understanding."

The results of Design 1 revealed that it is important to support visuals with texts to promote understanding. Three of the experts reported their opinions as follows:

Let us write "silver" under the visual of silver, "gold" under the visual of gold, and "salt" under the visual of salt (A5).

Gümüşün altına gümüş, altının altına altın ve tuzun altına tuz yazalım (A5).

Hocam, is it water or sugared water? Write what it is below the visual (A6).

Hocam bu su mu şekerli su mu? Altlarına yazılarını [ne olduklarını] yazın hocam (A6).

I think the visuals can be supported with texts (SET1).

Bence [görseller yazı ile] desteklenebilir olur (SET1).

iv. Providing examples/non-examples

Design Principle: "The material should provide example and non-example visuals for the target word."

One of the experts in dDsign1 explained that there should be both example and non-example visuals for the target word:

> *Let negative examples come after positive examples. For example, you can use honey here [while providing non-examples]. Honey is not a pure substance* (A5).
> *Olumlu örneklerden sonra olumsuz örnekler gelsin. Mesela balı burada [olumsuz örnek verirken] kullanabilirsin. Bal bir saf madde değildir* (A5).

b. Using videos/animations
i. Using videos/animations about what to teach

Design Principle: "The videos/animations to be used in the materials should focus on what to teach."

According to the results of Design 1, the videos/animation to be used in the material should focus on what to teach:

> *The animation is really well thought out. It provides good hints for students and makes understanding easier. However, it should be a little bit more explicit. Milk, egg, and sugar are used, but sugar and milk are both white. It would be better if it were more explicit* (A6).
> *[Animasyon] çok güzel düşünülmüş bir şey gerçekten ... İnanılmaz derecede güzel ipucu veren bir şey. Anlamayı çok kolaylaştıran bir şey. Sadece biraz daha hani belirgin olsa. Süt, yumurta, şeker koyuyor ama ikisi de beyaz ya. Daha belirgin bir video olsa daha güzel olur* (A6).

c. Using audio
i. Emphasized voice

Design Principle: "The audio to be used in the material should include a rising/falling intonation."

The findings of Design 1 also showed that the audio to be used in the material should include intonation:

> *If the vocalization button vocalizes the text below too, the underlines of the keywords and accentuation and intonation of them increase students' awareness. [She read some part of the text by accentuating]. It is essential because they might not distinguish and miss the necessary parts (SET1).*
> *Eğer bu seslendirme butonuna alttaki metin de eklenirse hem anahtar kelimelerin altında çizgi hem de vurgu ve tonlama da şöyle bir şey olabilir 'İçerisinde kendinden başka madde bulunmayan maddelere saf madde denir [Burada başka madde*

bulunmayan kısmını vurguladı ses tonuyla]. Çünkü gerçekten önemli yerleri ayırt edemedikleri için bazen kaçırdıkları oluyor (SET1)

ii.   Non-mechanical voice

Design Principle: "The audio to be used in the material should not be mechanical."

One of the experts participating in Design 1 explained that the voice to be used should not be mechanical:

> *Vocalization should not be mechanical. If the computer is going to read the text, it should not be mechanical. This sound is OK, if not distorted in long words* (A5). *Seslendirme mekanikleşmemeli. Bilgisayar okuyacaksa bu mekanik olmamalı. Uzun kelimelerde bu ses bozulmayacaksa bu ses güzel* (A5).

4.1.2.1.1.2 Instructions

Instruction is the second category of the theme principles of instructional design. The findings revealed its two sub-categories, as in the analysis phase: giving instructions to students about what to do and providing short, clear, and stepwise instructions.

a.   Giving instructions to students about what to do

Design Principle: "The material should give instructions to students about what to do."

One of the experts in Design 1 emphasized giving instructions to the students:

> *Something is missing here. Think of it like a child with learning difficulties reading the explanation or the question and then waiting. There should be something like "Read the explanation. If it is true, mark the true. If it is false, mark the false"* (A6). *Burada şu eksik biraz. Şöyle düşünün. ÖG olan çocuk buradaki açıklamayı ya da soruyu okur ve bekler. Şöyle bir şey olması lazım. ... Aşağıdaki cümleyi oku. Doğruysa doğruyu yanlışsa yanlışı işaretle* (A6).

b.   Short, clear, and stepwise instructions

Design Principle: "The instructions to be provided in the material should be short, clear, and stepwise."

According to expert opinions, the provided instruction should be short, clear, and stepwise:

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The instructions should be clear and short… (A6)
[Yönergeler] net, kısa olmalı… (A6)

4.1.2.1.1.3 Highlighting

Highlighting is the third category of the theme principles for instructional design and addressed within two sub-categories: highlighting target information and highlighting the selection area.

a. Highlighting target information

Design Principle: "The material should highlight the information/words to be taught."

As in the analysis phase, the results of Design 1 showed the importance of highlighting the information to be taught. Two experts in Design 1 explained their thoughts as follows:

> *If keywords can be underlined, students can be more careful... It is essential because they might not distinguish and miss important parts, which frequently happens* (SET1).
> *Anahtar kelimelerin altı çizili olabilirse daha dikkatli olabiliyorlar ... Çünkü gerçekten önemli yerleri ayırt edemedikleri için bazen kaçırdıkları oluyor.* (SET1).
>
> *The titles should be bold* (A6).
> *Başlıklarda kalın olsun hocam sayfalarda* (A6).

b. Highlighting the selection area

Design Principle: "The material should highlight the selection area."

The findings revealed that the target area should be highlighted:

> *Could you please change the background color of the empty box? It can be a different color. One or two tones darker... We can make it explicit by using contrasting colors* (A6).
> *Bu boş kutucuğun arka planını değiştirebiliyor musunuz? [Sürükle bırak etkinliğinde] ... Bir ton koyusu olabilir, 2 ton koyusu olabilir. Orada bir zıtlık yaratarak şey [daha belirgin hale getirmek] yapabiliriz belki.* (A6)

4.1.2.1.1.4 Interface Design

Interface design is the fourth category emerging in Design 1, the first design & development cycle. The findings revealed three sub-categories, as in the analysis phase (Table 17).

Table 17. Sub-categories of the category interface design

Sub-category	#Freq
a. Contrasting colors	2
b. Soft background colors	2
c. Providing information about the buttons	1

a. Using contrasting colors

Design Principle: "Contrasting colors should be used while designing the material."

Two experts highlighted the importance of using contrasting colors while designing the material:

> *Do not use pure white. Off-white or such tones are contrasting colors that make it easier to read. You did that well* (A5).
> *Pure beyaz olmasın. Kırık beyaz ya da bu tür tonlar kontrast [tonlar] okumayı kolaylaştıran renkler. Bunu iyi yapmışsın.* (A5)
>
> *It is hard to notice a text colored orange on white background. There should be a text with a more distinct color on white background* (SET1).
> *Beyaz fon üzerinde buradaki turuncu [yazı rengi] biraz zor seçiliyor. Beyaz üzerine daha belirgin bir renk olmalı.* (SET1)

b. Soft background colors

Design Principle: "Soft background colors should be used while designing the material."

Two experts emphasized the importance of soft background colors while designing the material. They mentioned their thoughts as follows:

> *You did a good job choosing soft background colors. Please, do not use pure white* (A5).
> *Soft renkler seçmekle iyi yapmışsın. Pure beyaz olmasın* (A5).

I would prefer the pale yellow one. The pages the children can read easily are often pale-yellow pages. It is neither pure white nor yellow (SET1).
Benim tercihim uçuk sarıdan yana olurdu diye düşünüyorum. Gerçekten rahatlıkla okuyabildikleri sayfalar uçuk sarı sayfalar. Ne tam beyaz ne de sarı (SET1).

c. Providing information about the buttons

Design Principle: "The material should provide information about the buttons used in the material."

The outcomes of Design 1 indicated that it is essential to provide information about the buttons to be used in the material:

Please, indicate the meaning of any buttons somewhere on the screen. For example, "Cross: Wrong. Try again" or "Tick(green): Correct" (A5).
Ekranda bir yere çarpının ve tikin anlamını yaz. Çarpı: yanlış Tekrar dene gibi. Yeşil: doğru kutuda kalsın (A5).

4.1.2.1.1.5 Practice

Practice is the fifth category of the theme principles for instructional design. The findings of Design 1 revealed two sub-categories of the category practice (see Table 18).

Table 18. Sub-categories of the category practice

Sub-category	n
a. Providing more interactions than the text	1
b. Simple to complex	1

a. Providing more interactions than the text

Design Principle: "The material should provide more interactions than the text in the practice part."

One of the experts explained that there should be more interactions than the text in the practice part:

Since the children have problems in reading, you had better not put too much text in the guided practice part. You should support this part with visuals… activities… (A5)

Çocukların okuması sıkıntılı olduğu için pratik alanını metine boğamazsın. Burada görsellerle … etkinliklerle…desteklemen lazım. (A5)

b. Simple to complex

Design Principle: "The practice part should follow a simple-to-complex course."

The findings of Design 1 indicated that the practice part should be designed in a simple-to-complex structure:

> *My advice would be to start with two examples, one true and one false. Then, there can be three examples in the second question. Finally, four visuals for the third question… In this way, the guided practice part will be a module where students get much feedback* (A5).
> *Benim kişisel önerim burada bir doğru bir yanlışsa başla. İkinci soruda tuz, altın, bal. Üçüncü soruda 4 örnek… Böylece bol miktarda feedback alabileceği bir yere dönüşür* (A5).

4.1.2.1.1.6 **Feedback**

Feedback is the last category emerging in theme principles for instructional design. According to the design & development cycle, it is addressed in six sub-categories (Table 19).

Table 19. Sub-categories of the category feedback

Sub-category	n
a. Importance of providing feedback	1
b. Offering immediate feedback	1
c. Using appropriate visuals for the feedback	2
d. Providing results in a graph	1
e. Giving students a chance to review the questions and their answers	1
f. Providing transition screens	3

a. Importance of providing feedback

Design Principle: "The material should provide feedback."

The Design 1 outcomes also highlighted the importance of providing feedback:

The child should not continue with a wrong answer. There can be feedback indicating that steel is not a pure substance. Let's take it back (A5).
Çocuk yanlış seçimle devam etmesin. Çelik bir saf madde değildir. Onu yerine alalım gibi bir geri bildirim gelebilir. (A5)

b. Offering immediate feedback

Design Principle: "The provided feedback should be immediate."

The findings showed that the material should provide immediate feedback. One of the participants uttered their opinions as follows:

When the child drags every word on the screen, there can be audio feedback such as "Congratulations! It is correct!" or "Steel is not a pure substance" (A5).
Her kelimeyi ekrana attığında tebrikler doğru ya da çelik saf madde değil filan gibi sesli feedback gelsin (A5).

c. Using appropriate visuals for the feedback

Design Principle: "The material should demonstrate appropriate visuals for the feedback."

Based on the findings of Design 1, it is important to use appropriate visuals while designing feedback:

We cannot give feedback with a smiley face for the wrong answer. The feedback for the wrong answer must be a neutral face. Not too sad, not too happy... Neutral. You can use neutrality as an expression (A5).
Gülen suratla yanlış feedback veremeyiz. Yanlış cevap feedback i tepkisizlik olmalı. Nötr surat olmalı. Çok üzgün değil mutlu değil. Tepkisizlik. Tepkisizliği ifade olarak kullanabilirsin (A5).

The screen designed for feedback is fun, but it smiles for the wrong answer. I could not distinguish it. I could not immediately understand that my answer was wrong (SET1).
Bu eğlenceli olmuş [feedback için tasarlanan pop-up ekran] ama yanlış cevapta da gülümsüyor mesela. Ben pek ayırt edemedim. Orada cevabımın yanlış olduğunu mesela hemen anlayamazdım. (SET1)

d. Providing results in a graph

Design Principle: "The material should provide results in a graph."

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According to the results of Design 1, the students should have a chance to see their test results in a graph:

> *It can be convenient if students could see their results in a graph. It can be a classic graph. The first column can show the number of correct answers, and the second one can indicate the number of wrong answers* (A6).
>
> *Grafik şeklinde görebilirse şeyi [sonuçları] güzel olur. Klasik grafik. Birincisi [ilk bar] doğruyu göstersin. İkincisi yanlışı göstersin* (A6).

e. Giving students a chance to review the questions and their answers

Design Principle: "The material should allow students to review the questions and their answers."

The results revealed that the material should allow students to review test items and their answers:

> *When the test is over, students should be allowed to check the questions left missing. The program can ask students whether or not they want to check the questions. There can be "Yes/No" buttons* (SET1).
>
> *Bittikten sonra da testlerde boşluğu varsa eğer yine bunu da seçenek olarak sunabiliriz. Yani dönmek ister misin? Hani yine kendisi isterse işte Soruya bakmak ister misin gibi. Evet, hayır butonu olup belki öyle devam edebilir* (SET1).

f. Providing transitions screens

Design Principle: "The material should provide transition screens for students."

The results indicated a need for transition screens to help students understand what they have done and what will come next. Two of the experts mentioned their views as follows:

> *There can be a warning screen alerting students for the next task: "It is the end of the drills. Now, let's do a test. Focus your attention!" …. You will be preparing students to see the questions. It will direct students' attention to the questions more* (SET1).
>
> *Kelimeler bitti hadi şimdi bir test yapalım diye yine onu hazırlayacak bir uyarı ekranı olabilir. Dikkatini toplaman lazım gibi… Çocuğu sorulara ve bir soruyla karşılaşmaya hazırlıyor olacaksınız. Dikkatini [sorulara] daha çok yöneltecektir* (SET1).

There is a need for a transition screen here. I choose the background color then it suddenly passes to the subject part. Vocabulary teaching starts. (A6).
Mesela burada bir geçişe bir şeyine ihtiyaç var. Şöyle ben burada şeyi arka planı seçiyorum ve bir anda olay şeye dönüyor. Neye dönüyor işte kelimeye anlam öğrenmeye başlıyoruz. (A6)

4.1.2.2 Design 2 – Second Design and Development Cycle

The outcomes of the second design and development cycle revealed principles of the theme principles for instructional design, explained in the analysis phase and Design 1. Table 20 presents are the categories and their frequencies pertaining to this theme.

Table 20. Categories of the theme principles of instructional design

Category
1. Multisensory Material
2. Instruction
3. Highlighting
4. Interface Design
5. Practice
6. Feedback

4.1.2.2.1 Principles for Instructional Design

4.1.2.2.1.1 Multisensory Material

Design Principle: "The material should appeal to multiple senses."

It is the first category of the theme principles for instructional design. The findings of the second design and development cycle also revealed that it could be addressed within three sub-categories: using visuals, using videos/animations, and using audio (Table 21).

Table 21. Sub-categories of the category multisensory material

Sub-category	n
a. Using Visuals	2
i. Using real/daily-life visuals	3
ii. Using big and clear visuals	5
iii. Supporting visuals with texts	1
iv. Providing examples/non-examples	1
b. Using videos/animations	1
i. Using videos/animations about what to teach	2
c. Using Audio	1
i. Emphasized Voice	1

One of the experts explained their thoughts about designing a multisensory material as follows:

> *It is easier for students with learning difficulties to make sense of abstract and unrelated things with visual material…. Absolutely, it is even much more comfortable to associate it with multimedia-supported materials.* (A7)
> *Öğrenme güçlüğü olan öğrenciler genelde soyut olan ve ilişkilendirilemeyen konularda görsel bir materyal ile onun anlamlandırması daha şey [iyi] oluyor…Kesinlikle. [multimedia destekli materyal ile] İlişkilendirmede de daha rahat olabilmekte.* (A7)

a.   Using visuals

Design Principle: "The vocabulary teaching should be supported with visuals."

The findings highlighted the importance of using visuals to support vocabulary teaching, as in the results of the analysis phase and Design 1:

> *Besides five positive examples, it is absolutely necessary to include two or three negative examples…. It seems that there is a need to strengthen the visual aspect of the material a little more so that students can understand the difference between them* (SET9).
> *Beş tane olumlu örnek veriyorsak 2 tane 3 tane olumsuz örneğe mutlaka yer vermek gerekiyor... Arasındaki farkı anlayacakları o görselliği birazcık daha kuvvetlendirmeye ihtiyaç varmış gibi geldi hocam bana* (SET9).

> *It is easier for students with learning difficulties to make sense of abstract and unrelated things with the help of visuals* (A7).
> *Öğrenme güçlüğü olan öğrenciler genelde soyut olan ve ilişkilendirilemeyen konularda görsel bir materyal ile onun anlamlandırması daha şey [iyi] oluyor* (A7).

i. Using real/daily-life visuals

Design Principle: "The visuals used in the material should be real/daily-life oriented."

According to the results of Design 2, three experts explained that the visuals used in the material should be real/daily-life oriented. One of them expressed that:

> *Children do literally not have experience with the pebbles and sand example. We live in houses heated with natural gas. The children do not know about coal or coal dust (SET9).*
> *Çakıl ve kum durumunu [örneği] yaşantı deneyimleri yok. Gerçekten yok yani. Doğalgazlı evlerde yaşıyoruz kömürü kömür tozunu bilen yok (SET9).*

ii. Using big and clear visuals

Design Principle: "The visuals to be used in the material should be big and clear enough to understand the target word easily."

Five experts noted that the visuals should be big and clear enough to understand. Two of them disclosed their ideas by saying:

> *As I said, the visuals should be more robust and distinct. There is a color difference between these two substances (SET9).*
> *Bir de görsellerin dediğim gibi biraz daha kuvvetli olması gerekiyor. Daha belirgin bir şekilde…. Bu ikisi [görseldeki iki madde] arasında bir fark var ama renk farkı var (SET9).*
>
> *The visuals have become clearer… By the way, the visuals are outstanding Well, they are pretty obvious (A6).*
> *Resimler bu arada çok daha belirgin olmuş… Bu arada bu görseller gayet şey olmuş hocam. Hani net artık ben buradayım diyor (A6).*

iii. Supporting visuals with texts

Design Principle: "The visuals should be supported with a text to promote understanding."

The results of Design 2 also emphasized the importance of supporting visuals with a text to promote understanding:

> *It seems a good idea to write what the visuals refer to under them.* (SET1)
> *Altlarında yazıların yazılması da bence çok güzel olmuş.* (SET1)

iv. Providing example/non-examples

Design Principle: "The material should provide example and non-example visuals for the target word."

The second design and development cycle yielded that example and non-example visuals for the target word should be provided. One of the teachers noted that:

> *What is a pure substance? It is salt or copper. However, we should not think that saying "a pen is not a substance" makes students learn the concept. We need to diversify the examples. Besides five positive examples, it is absolutely necessary to include two or three negative examples* (SET9).
> *Hani saf madde nedir? Tuzdur, bakırdır diyoruz ya. Kalem bir saf madde değildir diye tek bir durum üzerinden o elemeyi yapmayıp yani şey o kavramı öğrenmiş gibi düşünmeyip birazcık daha örnekleri çeşitlendirip. Beş tane olumlu örnek veriyorsak 2 tane 3 tane olumsuz örneğe mutlaka yer vermek gerekiyor* (SET9).

b. Using videos/animations

Design Principle: "The vocabulary teaching should be supported with videos."

The design outcomes also highlighted the importance of supporting vocabulary teaching with videos/animations:

> *These videos are all OK, hocam. It is a good idea to add them here because an audio stimulus has directed my attention more into it…. Children lose their attention when they do the same thing repeatedly. However, providing an audio stimulus may be good* (SET1).
> *Bu videolar çok güzel olmuş hocam. Çok güzel ama yani buraya eklenmiş olması, sesli bir uyaranın birden devreye girmesi, benim dikkatimi daha çok buraya yöneltti mesela…. Çocuklarda öyle oluyor. Aynı işlemi sürekli uygulamaya başlayınca daha çok şey yapıyorlar. Kopup gidiyorlar ama arada sesli bir uyaranın verilmiş olması çok güzel* (SET1).

i. Using videos/animations about what to teach

Design Principle: "The videos/animations to be used in the materials should focus on what to teach."

Two teachers who contributed to the design and development cycles explained that the videos focused on what to teach should be used in the material:

The video passes over the substances very quickly … If the video tells about them at this pace… if five or six substances are counted successively, my students can remember only three or four of them (SET8).
Video çok hızlı bir şekilde sayıyor ya tuz, su, şeker... Bunu bu şekilde 5-6 tane arka arkaya saydığınız takdirde, 3 ya da 4 tanesi akılda kalır. 5.si akıllarında kalmıyor (SET8).

The video is a bit fast-paced. An animated character should remind everything again by highlighting each substance in the foreground (SET9).
Video koyulacaksa bu biraz hızlı. Her söylenen şeyi animasyon bir karakter olarak ekranda ön plana gelecek şekilde tekrar hatırlatmalı (SET9).

c. Using audio

Design Principle: "The vocabulary teaching should be supported with audio."

One of the experts explained that vocalization is essential for LD students. She reported that:

Having such vocalization would be a plus for our students with learning difficulties (A7).
Bizim öğrenme güçlüğü olan öğrenciler için böyle bir seslendirmenin ses okuyucusunun olması bile artı bir durum olabiliyor (A7).

i. Emphasized voice

Design Principle: "The audio to be used in the material should include a rising/falling intonation."

One of the experts interviewed in the second design and development cycle noted that using intonation would attract students' attention:

The difference in intonation definitely attracts children's attention (SET8).
Ses tonunun farklılığı mutlaka [dikkatini] çeker (SET8).

4.1.2.2.1.2 Instruction

a. Short, clear, and stepwise instructions

Design Principle: "The instructions to be provided in the material should be short, clear, and stepwise."

According to the results, one of the experts stated that the information to be provided in the material should be short and clear:

> *"Salt can be given as an example of a pure substance. I wondered if we should write something instead. For example, "Salt is a pure substance." This is my opinion, of course. Please, keep everything short and to the point (A6).*
> *Tuz saf maddelere örnek olarak verilebilir yerine acaba şey mi yazsak diye düşündüm. Tuz bir saf maddedir. Bu benim fikrim tabi. Kısa ve öz olsun her şey* (A6).

4.1.2.2.1.3 Highlighting

Highlighting is the third category of the theme principles for instructional design. According to the findings, two sub-categories emerged in the second design and development cycle: highlighting target information and the selection area.

a. Highlighting target information

Design Principle: "The material should highlight target information/words to be taught."

The outcomes indicated that the information or the words to be focused on should be highlighted in the material:

> *The word "değildir" in the non-examples can be highlighted... They can be colored red or underlined and appear in a different font size... Children automatically complete the sentence without fully reading it. Please, highlight negative suffixes in the material (SET1).*
> *Hocam belki bir de şu değildir yazıları vurgulanabilir. Değildir yazısı kırmızı ya da altı çizili olabilir. Puntosu farklı olabilir... bu sonlara denk gelen kelimelerde çok fazla otomatikleşiyorlar hemen. O yüzden olumsuz örneği verirken vurgulayalım* (SET1).

> *In the explanations of the examples, many children will confuse "ayıramayız" with "ayırırız" ... These words can be highlighted in different colors (SET8).*
> *Mesela şey buralarda da [olumsuz örneklerdeki açıklamalar] ayıramayız. Bunu ayırırız diye okuyacak birçoğu... Altı çizilebilir, farklı renkte yazılabilir* (SET8).

b. Highlighting the selection area

Design Principle: "The material should highlight the selection area."

Two of the experts emphasized the importance of highlighting the selection area:

After choosing the background color, it is necessary to highlight the frame of the background with a more vibrant color so that children recognize what they choose (A5).

Rengi seçtikten sonra onu [renk kutusunu] seçtiğini anlaması için daha canlı bir renk kullanarak belirginleştirmek (etrafındaki çerçeveden bahsediyor) lazım (A5).

4.1.2.2.1.4 Interface Design

Interface design is the fourth category of the theme principles for instructional design and includes a sub-category scroll bar.

a. Scroll bar

The results of Design 2 revealed that using a scroll bar to see the whole text would be convenient but may distract students' attention:

When the children scroll to see the whole text, they can lose the line they are left, and it might distract their attention. It might be convenient to divide the text into two parts. (A5)

Metnin tamamını görmek için kaydırdığında çocuk kaldığı yeri kaybedebilir ve bu dikkatini dağıtır. Belki metni 2 parçaya bölmek uygun olabilir. (A5)

4.1.2.2.1.5 Practice

The practice is the fifth category with four sub-categories. Table 22 presents sub-categories and the frequencies for the category practice.

Table 22. Sub-categories of the category practice

Sub-category	n
a. Importance of providing practice	1
b. Providing more interactions than the text	4
c. Offering a chance to revisit the subject screen	3
d. Presenting information cumulatively	3

a. Importance of providing practice

Design Principle: "The material should provide a chance to practice target words."

One of the participants highlighted the importance of providing a chance to practice target words:

> *The material directly presents the target information. It includes an independent study area but nothing about guided practice. Here we need a part where children can practice what they have learned with feedback. They should see the word and practice it* (A5).
> *Materyalde doğrudan sunum var. Bağımsız çalışma var ama rehberli uygulamaya dair bir şey yok. Burada çocuğun geri bildirim alarak pratik yapabileceği çalışabileceği bir kısım lazım. Çocuk kelimeyle daha çok karşı karşıya gelmeli. Pratik yapabilmeli* (A5).

b. Providing more interactions than the text

Design Principle: "The material should provide more interactions than text in the practice part."

Four participants agreed that the practice part should include more interactions and less intense text. They stated:

> *The visuals can be used again in the guided practice area. You can match visuals with texts... I offer this to get benefit from the power of visuals. Instead of dragging the texts "silver" and "salt," we can use the power of visuals* (SET9).
> *Görselle yazı eşleştirmesi de yapılabilir... Görselin kuvvet gücünden yararlanmak için diyorum. Yani gümüş yazısını tutup sürüklemek, tuz yazısını sürüklemektense birazcık daha görselin kuvvetinden faydalanmak için...* (SET9)

> *Children should encounter the word and make practice it. It will be very dull if they pass to the independent study area following the presentation. Interaction should be increased, or it will be like a PowerPoint presentation* (A5).
> *Çocuk kelimeyle daha çok karşı karşıya gelmeli. Pratik yapabilmeli. Doğrudan sunumdan sonra direk bağımsız çalışma alanına giderse çok sıkıcı olur. Çocuğun etkileşimini artması gerek yoksa power point sunusu gibi olur.* (A5)

c. Offering a chance to revisit the subject screen

Design Principle: "The material should offer a chance to revisit the subject screen."

In the second design and development cycle, three experts claimed that the material should offer a chance to revisit the subject screen when needed:

> *Can there be revisiting the teaching part following a wrong answer? The material can ask children if they want to go to the relevant part of the topic* (SET1).
> *Yanlış cevaptan sonra bir öğretim olabilir mi? Konunun ilgili kısmına gitmek ister misin diye sorsun çocuğa.* (SET1)

I deliberately gave wrong answers. Can teaching be planned after each wrong answer... to the previous stage [the part where the words were taught]? ... (SET9)
Bilerek yanlış cevaplar verdim sürekli. Her yanlış cevaptan sonra bir öğretim planlanabilir mi? Önceki aşamaya ... (SET9)

Yes. There can be a link to go back to the subject screen ... I think that going back to the subject screen can help reinforce learning of the concept (A7).
Evet. Konuya dönebileceği bir link verebilir ... Konuya dönmenin o kavramı öğrenmeyi daha da pekiştirebileceğini düşünüyorum (A7).

d. Presenting information cumulatively

Design Principle: "The material should present the information cumulatively."

The Design 2 findings indicated that the information should be provided cumulatively. Three of the experts reported their thoughts as follows:

Is it possible to create something like a map after the vocabulary teaching part? Of course, with relevant visuals... We could make concept maps and put related visuals together. For example, salt, water, and sugar are some kitchen stuffs. Putting related visuals together will make it easy to group and keep them in mind (SET8).
Belki bir harita gibi bir şey yapılabilir mi buraya [her kelime öğretiminin ardına]? Tekrar görseller birlikte.... Kavram haritası gibi bir harita yapılıp, tuz, su, şeker bunlar mutfakta kullanılan malzemeler ya. Gruplaması ve zihninde tutması daha kolay olur (SET8).

I like the design of the screen where all the words and their meanings are provided. It supports self-regulation and self-instruction. Students will check whether they have understood the target information. Metacognitive strategies... (A6)
Güzel, şey [öğrenilen kelimelerin tekrar toplu sunulduğu ve isterse anlamına baktığı alan]. Kendini düzenleme, kendini talimatlandırma. Anlayıp anlamadığını kontrol etme. Üst bilişsel stratejiler. (A6)

I like the screen where all the target words and their definitions are given before reading the text because it offers students a chance to revisit the information about the target word if they forget it. After that, it would be nice to have an instruction, like "Start reading the text when ready! (A7).
Ben bunu [metin öncesi kelimelerin anlamlarını görebildiği ekran] da sevdim çünkü bilgi edinmek için kelimeye tıkla hatırlamadığın. Çünkü bundan sonra hazırsan okumaya başlıyoruz şeklinde bir yönergenin olması bile güzel olabilir (A7).

4.1.2.2.1.6 Feedback

Feedback, consisting of five sub-categories, is the last category of the theme principles for instructional design (Table 23).

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Table 23. Sub-categories of the category feedback

Sub-category	#Freq
a. Importance of providing feedback	2
b. Offering immediate feedback	3
c. Providing results in a graph	1
d. Giving students a chance to review the questions and their answers	2
e. Providing transition screens	3

a. Importance of providing feedback

Design Principle: "The material should provide feedback."

Two experts joining in the second design and development cycle argued that providing feedback is essential. They noted that:

> *Children need to get feedback from the screen. Getting feedback on what they have done wrong, and right is crucial (SET9).*
> *Çocuğun ekrandan kendi geri dönütünü alması çok önemli neyi yanlış yaptığının, neyi doğru yaptığının geri dönütünü alması da çok önemli (SET9).*

> *Then, it is important to get feedback. It might be good for children to get feedback about why their answer(s) is wrong (A7).*
> *O zaman bir geri bildirim olması önem arz edecek ... Bunun neden yanlış olduğuna ilişkin [geri bildirim] görmesi iyi olabilir (A7).*

b. Offering immediate feedback

Design Principle: "The provided feedback should be immediate."

Three experts recommended that feedback should be given be immediately after the practice:

> *Is it better to give feedback immediately without waiting until the end ... Feedback should pop up when students click the visual (SET1).*
> *Burada çocuğa anında geri dönüt verilmesi daha mı iyi olur diye mesela sonunu beklemeden?... İşaretlediği an çıksa çünkü mesela ben şurayı kaçırdım. (SET1)*

> *Instead of using a button to check whether answers are correct, there can be tick and cross signs over the lemonade visual ... What I recommend for the practice part is that it should give immediate feedback (SET8).*
> *Cevabını kontrol ete [butonuna] gitmektense, bu limonatanın üstünde tik ya da çarpı, suyun üstünde tik ya da çarpı çıkabilir mesela (SET8).*

When children click "pure substance," there will be feedback like "Congratulations! It is correct!" When they click wrong answers, there will be feedback like "Try again!" or "It is not a pure substance!" (A5).
Çocuk saf madde olana tıkladığında tebrikler doğru, yanlış cevaba tıklarsa tekrar dene ya da saf madde değil gibi geri bildirim gelecek (A5).

c. Providing results in a graph

Design Principle: "The material should provide results in a graph."

In Design 2, the findings revealed that the results should be presented in a graph:

It would be nicer to provide students with graphical feedback and the opportunity to review their answers (A6).
Bu güzel, grafiksel dönüt. Şu cevaplara geri dönme şeyi de güzel olmuş onu incelemiştim zaten (A6).

d. Giving students a chance to review the questions and their answers

Design Principle: "The material should allow students to review the questions and their answers."

The findings of Design 2 indicated that the online learning material should give students a chance to review their answers and the questions. One of the experts stated that:

If students are able to see what their mistakes are, they can have a chance to notice that they actually know the answer, but they made a lexical error (A7).
Süreç sonunda eğer hatalarının ne olduğunu görebilecekse aaa ben bunu kelime hatasından yapmışım, biliyorum aslında cevabı deme şansı olabilir.... Öyle bir şeyin [cevaplarını inceleme şansının] olması güzel olur (A7).

e. Providing transition screens

Design Principle: "The material should provide transition screens for students."

The findings of the second design and development cycle showed that providing transition screens is essential. Three of the participants mentioned it as follows:

Transition screens on the material look very good (SET1).
Geçiş ekranı da çok iyi olmuş hocam (SET1).

The transition screens I mentioned before are all OK (A6).
Şey çok iyi olmuş hocam. Bu bahsettiğim geçişler var ya çok güzel olmuş (A6).

I like the screen showing the learning progress step by step. It shows, "You have learned pure substance, mixture, and sieving," "Congratulations," and "Now, you will learn the word 'süzme'." In this way, children would be aware of what words come will appear on the screen (A7).
Ben şeyi de çok sevdim. Özellikle şuradaki geri dönütte [geçiş ekranında] ne öğrendiğine ilişkin aşama aşamayı yazıyor. Saf madde, karışım, eleme kelimesini öğrendin. Tebrik ederim. Şimdi sırada süzme gibi. Yani çocuk süreç içerisindeki hangi kelimenin hangisinden sonra geldiğinin de farkında. Bir aşamalık söz konusu (A7).

4.1.2.3 Design 3 – Third Design and Development Cycle

The third design and development cycle yielded principles pertinent to the theme principles for instructional design, explained in the analysis phase, Design 1, and Design 2 (Table 24).

Table 24. Categories of the theme principles for instructional design

Category
1. Multisensory Material
2. Instruction
3. Highlighting
4. Interface Design
5. Practice
6. Feedback

4.1.2.3.1 Principles for Instructional Design

4.1.2.3.1.1 Multisensory Material

Design Principle: "The material should appeal to multiple senses".

The multisensory material is the first category in the third design and development cycle. The result showed that addressing multiple senses is important for LD students:

I think it can be good for children to repeat the text visually and audibly … In this way, they can see and hear the text… it can be better for them (SET1).
Çocuğun bence hem sesli olarak hem de görerek o yazıyı tekrar etmesi iyi olabilir... Yani bir kere işitsel olarak metni hem görüyor hem dinliyor. O yüzden daha iyi olabilir hocam (SET1).

According to the findings, the category would be addressed within three sub-categories. Table 25 presents the sub-categories and their frequencies.

Table 25. Sub-categories of the category multisensory material

Sub-category	n
a. Using Visuals	
i. Using real/daily-life visuals	1
ii. Using real photos	1
b. Using videos/animations	2

a. Using visuals

i. Using real/daily-life visuals

Design Principle: "The visuals to be used in the material should be real /daily-life oriented."

One participant explained the importance of using real/daily-life oriented visuals in the material. She stated that:

> *Providing examples from children's daily lives would increase the permanence of knowledge acquired... If they have no experience with the visuals, they could not establish a schema of the target knowledge (SET8).*
> *Yani günlük yaşantısından örnekler vermek hem onun aklında kalıcılığını arttırır ... Çocuğun eğer bu yöntem ile ilgili ya da o görselle ilgili herhangi bir yaşantısı yoksa zihninde herhangi bir şema oluşmayacak (SET8).*

ii. Using real photos

Design Principle: "The visuals to be used in the material should be real photos."

One of the experts claimed that the visuals should be real photos to promote students' understanding:

> *For example, there is a vector sketch of soup.... They have drawn eyes and eyebrows on the soup to make it cuter, but they cannot get it. It distracts their attention much because they do not have an experience with that (SET8).*
> *Mesela çorbanın vektör çizimi oluyor... Çorbanın üstüne kaş göz çizmişler sevimli hale getirmişler ama çocuk bunu anlamıyor. Dikkatini çok dağıtıyor çünkü çorba yaşantısı bu değil. Kaş gözlü ağızlı bir çorba değil (SET8).*

b. Using videos/animations

Design Principle: *"The vocabulary teaching should be supported with videos."*

The results of Design 3 also highlighted the importance of using videos to support vocabulary teaching. Two of the participants mentioned it as follows:

> *... the video is an attention-grabbing element. So, they can continue to watch it* (SET1).
> *... video daha dikkat çekici bir unsur orada devam ederler diye düşündüm* (SET1).

> *The use of videos is a good idea because sieving is an activity that children can see in their daily lives. They come across it a lot in the kitchen* (SET8).
> *Bu videonun kullanımı çok iyi olmuş çünkü neden elek olayı çocukların günlük yaşamında çok olan bir olay. Yani mutfakta çok karşılaştıkları bir olay* (SET8).

4.1.2.3.1.2 Instructions

a. Short, clear, and stepwise instructions

Design Principle: "The instructions to be provided in the material should be short, clear, and stepwise."

The findings also revealed the importance of providing students with short, clear, and stepwise instructions. Two of the experts expressed their thoughts as follows:

> *We use concise, short, and clear instructions in special education, like do, select, plug, show… That's it* (SET8).
> *Özel eğitimde şey kullanırız… Çok net, sade, çok kısa yönergeler kullanırız. Yap. Seç. Tak. Göster. Bu kadar.* (SET8)

> *"Silver is not a mixture." Being concise and clear seems to make our job easier* (A6).
> *"Gümüş bir karışım değildir". Öz ve net olmak biraz daha işimizi kolaylaştıracak gibi geliyor* (A6).

4.1.2.3.1.3 Highlighting

a. Highlighting target information

Design Principle: "The material should highlight the information/words to be taught."

The third design and development cycle also indicated that target information should be highlighted:

...highlighting makes the expression "değildir" more explicit. Last time, when I read the sentences successively, the expression "değildir" did not take my attention. (SET1).

... değildir yazısı daha vurgulu olunca, net görünmüş hocam. Geçen sefer mesela üst üste okurken çok otomatik artık başladığımız için değildir biraz dikkati şey yapıyor demiştim. Dikkatleri üzerine çekmiyor pek. (SET1).

Are the negative words underlined? Students may confuse negative words with positive ones, so they may mark the wrong options (SET8).

Olumsuz kelimeler in altı çizili mi? Olmamalıdır filan gibi soruları olmalıdır gibi okuyorlar çünkü yanlış cevap verirler (SET8).

4.1.2.3.1.4 Interface design

a. Consistency

Design Principle: "The design of the material should be consistent."

The results revealed that the online learning material should offer consistent content to students:

> *It is a good idea to follow the same pattern in the vocabulary test because children know what to do, will write here, and will not ask about it again... When it is not consistent, they will ask what they will do every time (SET8).*
> *Burada da [kelime testinde] aynı düzenin olması güzel. Ne yapacağını biliyor çünkü. Biliyor ki burada [sorunun açıklama kısmında seç, işaretle yönergelerinden bahsediyor hoca] yazacak. Bir daha sormayacak size.... Düzensiz bir şekilde olduğunda her defasında soracak. Burada ne yapacağım, burada ne yapacağım? (SET8)*

4.1.2.3.1.5 Practice

a. Providing more interactions than the text

Design Principle: "The material should provide more interactions than text in the practice part."

The outcomes also emphasized that the practice part should include more interactions and less intense text:

> *The intensity of texts in the test items decreased drastically. It was essential because the child would get tired in the subject part. You know their attention span is too short... (SET8)*

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O sondaki değerlendirme sorularındaki o yazı yoğunluğu ciddi oranda azalmış. O çok önemliydi. Zaten burada [konu kısmında] yorulacak. Dikkat süreleri kısa…(SET8)

b. Offering a chance to revisit the subject screen

Design Principle: "The material should provide a chance to revisit the subject screen."

Two experts highlighted the importance of giving students a chance to revisit the subject screen:

> *The student can close the feedback screen and go back to the subject screen. I think it is a good idea* (SET1).
> *[Geri bildirimi] direk kapatıp devam da edebiliyor, konuya da dönebiliyor. Çok güzel olmuş bence* (SET1).
>
> *It is an excellent way to get back to the subject part* (A5).
> *O [takıldığı yerde konuya dönmek] iyi bir yoldur* (A5).

c. Going back to the last screen after revisiting the subject screen

Design Principle: "The material should provide a chance to go back to the last screen."

The results of Design 3 showed that the material should give students a chance to go back to the question (last screen) they have left after revisiting the subject screen:

> *After visiting the subject part, students must review the questions again. Do not do this, please! They should go back to the question they have left* (A5).
> *Konuya gittikten sonra bütün soruları baştan geçiyor…. Geçmesin. Kaldığı soruya dönsün* (A5).
>
> *Yes, it was well thought to give chance students to return to the question they have left* (A7).
> *Aaa evet bu [öğrencinin kaldığı soruya dönmesi] güzel düşünülmüş* (A7).

d. Presenting information cumulatively

Design Principle: "The material should present the information cumulatively."

Three of the experts emphasized the importance of presenting information cumulatively. They expressed their opinions as follows:

You move on cumulatively. I think this screen where you provide all visuals of the word together is really good… It is nice to support what has been learned with visuals for the last time before passing the test (SET1).

Kümülatif olarak devam ettiniz. Bence şu ekran [kümülatif olarak örneklerin sunulduğu ekran] gerçekten çok iyi olmuş hocam …En azından şimdiye kadar olanları bir toparlayıp son artık sorulara geçmeden önce son kez görsellerle desteklemek çok güzel olmuş. (SET1)

It is good to see all examples of pure substances together and adopt this structure for all the words to be taught… We accumulate the information and present it cumulatively at the end…. Actually, we schematize it... We try to increase the permanence of the knowledge by schematizing it (SET8).

Hani saf madde örnekleri, bunların hepsini tekrar burada bir arada görüyor olması ve bunun saf madde, karışım, eleme ve süzme içinde aynı düzende gidiyor olması çok güzel… Bilgiyi birikerek götürdük. Kümülatif sunduk ama en sonda da ... onu bir şemanın içine dahil ettik…. Bilgiyi şematize ederek kalıcılığını arttırmaya çalıştık. (SET8)

The screen is good for seeing all examples together... It is a kind of cumulative repetition that I have mentioned before (A6).

Bence [bütün örnekleri] toplu olarak görmesi açısından güzel... Size söylediğim o her bölüm bittiğinde kümülatif olarak şunu öğrendik şeyinin bir versiyonu (A6).

4.1.2.3.1.6 Feedback

a. Offering immediate feedback

Design Principle: "The provided feedback should be immediate."

One of the participants explained that the material should give immediate feedback to help students understand whether their answers are correct:

It is better this way. It is very good to get feedback after each answer (A7).
Bu şekilde daha güzel olmuş. Her bir şeyden [cevaptan] sonra geri bildirim alması daha güzel olmuş (A7).

b. Appropriate tone of language for the feedback

Design Principle: "An appropriate tone for the feedback should be considered in the material."

The results showed that the tone of language used in the feedback is important. One of the experts mentioned it by saying:

*Instead of saying, "Your answer is not correct," you may say, "Check your answer…"
Yet, feedback in the material says, "Your answer is not correct." It is not the way we
give feedback to children with learning difficulties* (A5).
*Şimdi cevabın yanlış yerine kontrol et, cevabını kontrol et gibi bir şey… Burada
cevabın yanlış yazıyor ya. Bizim bu çocuklarda [öğrenme güçlüğü olan çocuklarda]
çok fazla kullanmadığımız bir şey.* (A5)

c. Designing feedback keeping the flow of the practice

Design Principle: "The feedback should be designed in a way keeping the flow of the
practice."

According to the results, the feedback screen should be designed not to disturb the
flow of the practice. Three of the participants expressed their thoughts by saying:

> *It may be overwhelming to see the feedback screen every time… Although providing
> such an opportunity is excellent, I think closing the feedback window each time can
> be distractive … It can be distractive to click it every time* (SET1).
> *Her seferinde o ekranın [pop-up feedback ekranı] çıkması biraz zorlayıcı olabiliyor…
> Böyle bir opsiyon sunulması güzel ama çok fazla da dikkat dağıtıcı bir unsurmuş gibi
> geldi … Her seferinde oraya tıklıyor olmak biraz dikkat dağıtıcı olabiliyor gibi*
> (SET1).
>
> *Regarding the interruption of the flow… it comes out when you try it with children.
> You had better be careful about it. Observe whether or not they can use it comfortably.
> How does closing the feedback window after studying every item affect them?* (A5)
> *Akışın kesintisiyle bağlantılı olarak… çocuklarla uyguladığında çıkar o ortaya ama.
> Çocuklarla uygularken buna dikkat et. Bir bak bakalım rahat kullanabiliyorlar mı?
> Her seferinde tekrar girip çıkmak [feedback için çıkan pop-up ekranı kapatmaktan
> bahsediyor] nasıl şey [etkiliyor] yapıyor onları?* (A5)
>
> *Popping up the feedback window every time children drag each item may interrupt
> the flow (A6).*
> *Her defasında az önceki şeyin [feedback için pop-up ekran] gelmesi akıcılığı biraz
> bozuyor.* (A6).

d. Giving students a chance to review the questions and their answers

Design Principle: "The material should allow students to review the questions and the
answers."

The third design and development cycle outcomes also revealed that the students should have a chance to review the questions and their answers. One of the participants stated:

> *The review button and the go back to results buttons are very nice.* (A7)
> *Bu iki buton da [review et ve sonuç ekranına dön] çok harika olmuş…* (A7)

e. Providing transition screens

Design Principle: "The material should provide transition screens for students."

One of the participants explained his thoughts about including the transition screens in the material as follows:

> *It is a good idea to integrate transition screens in the material, but can it be like that: "Congratulations, you have learned the words pure substance, mixture, and sieving!" with ticks. The three words can be placed under the other, unlike a sentence. Would it be better to show progress as well as in the other transition screens?... The transition screen is good because it provides feedback. Students can evaluate themselves (A6).*
> *Burası [geçiş ekranları] çok güzel acaba şöyle mi olmalı? Tebrikler, bir tik işareti saf madde, bir tik işareti karışım, tik işareti eleme kelimelerini öğrendin. Üçünü alt alta mı görse burada cümle gibi değil de. Aradaki diğer geçişlerde de öyle onun kümülatif olarak ilerlediğini göstermek sanki daha mı iyi olur?... Şu güzel olmuş kendine feedback veriyor. Kendini değerlendirme…*(A6)

4.1.2.4 Pilot Study – Fourth Design and Development Cycle

The pilot study was the fourth design and development cycle. Two fourth-grade LD students participated in this cycle. The students used the online learning material, and their experiences were observed and noted down. Following the pilot study, the researchers compared and discussed their notes. The main points extracted from the notes are presented below.

Providing a Simple Definition for the Target Word

Design Principle: "A simple definition for the target word should be provided while teaching vocabulary."

Two of the observers took notes about the definitions and agreed that the definitions should be simple, short, and clear enough to be understood. Since a student had

difficulty reading and remembering the words' definitions, particularly in the practice and vocabulary test parts, the observers decided to shorten the definitions.

Using Visuals

Design Principle: "The vocabulary teaching should be supported with visuals."

Two researchers pointed out the importance of using visuals in vocabulary teaching. At the beginning of the study, the students did not know the words. Yet, they examined the visuals while studying them, remembered the visuals of the words, and answered the questions correctly in the practice and vocabulary test parts.

Supporting Visuals with Texts

Design Principle: "The visuals should be supported with texts to promote understanding."

One of the observers noted that supporting visuals with texts is essential. Throughout the material, all the visuals are supported by several texts. In other words, the material includes texts explaining the visuals. Yet, the material does not show the texts on the screens for the words to avoid confusion. Instead, students can ask for the texts if having difficulty with the visuals.

Using videos/animations about what to teach

Design Principle: "The videos/animations to be used in the materials should focus what to teach."

Both observers agreed that the videos should focus on what to teach and should not include any misleading information or visuals since there was a misleading visual in one of the videos that made students misunderstand the target information.

Highlighting target information

Design Principle: "The material should highlight the information/words to be taught."

One of the observers acknowledged the importance of highlighting relevant information to help students. Two students had problems reading and understanding

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the definitions, missed their critical parts, and could not solve any definition-related questions. In addition, the other observer explained that it is also essential to highlight the relevant information in the test to attract students' attention.

Providing more interactions than the text

Design Principle: "The material should provide more interactions than texts in the practice part."

Two researchers observed that there should be more interaction than texts, especially in the practice part. Some students had problems with definition-related questions because of the intensive content of the texts. Despite spending more time, they could not give any correct answers. Thus, the observers agreed on removing definition-related multiple-choice questions.

Providing immediate feedback

Design Principle: "The material should provide immediate feedback."

One of the observers emphasized the critical role of providing immediate feedback. Two students liked to get immediate feedback for their activities and gave the following reactions after the feedback: "Yes, it is correct!" and "This is a pure substance, but this is not."

4.1.3   Finding of the Implementation & Evaluation Phase

In the implementation & evaluation phase, students used the online learning material. While studying, the researcher took observation notes and filled out an observation rubric. Moreover, the researcher directed a semi-structured interview with the students to learn about their experiences. Below are the findings based on the observation notes.

4.1.3.1   Multisensory Material

a.   **Using visuals**

Design Principle: "The vocabulary teaching should be supported with visuals."

The interview results also showed that vocabulary teaching should be promoted with the help of visuals:

> *I remembered the words from the pictures (S5).*
> *Mesela resimlerden aklımda kalıyordu [kelimeler] (S5).*
>
> *Visuals are better because how can I say... When there are visuals, I can understand them better (S12).*
> *Görseller biraz daha iyi oluyor çünkü onlardan nasıl desem... Her şeyde görseller olsa zaten ben çok iyi çözüyorum. (S12)*

b. Using audio

Design Principle: "The vocabulary teaching should be supported with audio."

The findings of the analysis and design & development phases highlighted the importance of supporting vocabulary teaching with audio. The observation notes also revealed that nearly half of the students ($n = 6$) used the audio buttons to vocalize the texts on the screen in the implementation & evaluation phase. Especially students with low reading fluency preferred to vocalize the text and repeated the target information using their body language (e.g., nodding). Yet, the students ($n = 7$) with higher reading fluency levels explained that they did not prefer to use the button because they did not need it.

i. Emphasized voice

Design Principle: "The audio to be used in the material should include a rising/falling intonation."

The observation results showed that students (n=3) who vocalized the texts by using the audio button noticed the intonations. They tried to accompanied the audio by imitating intonations for the negative words loudly. They also shake their heads to right and left to confirm the negativity.

4.1.3.2 Highlighting

a. Highlighting target information

Design Principle: "The material should highlight the information/words to be taught."

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The interview results also emphasized the importance of highlighting target information. The students explained their opinions as follows:

> *It helped me a lot because the words were written in red. It grabbed my attention* (S13).
> *Kırmızı kalemle yazıldığı için çok işime yaradı. Dikkatimi çekti* (S13).

> *If the word was not colored, I could read it wrong or misunderstand its meaning. Since it is written in red, I could understand that the word has a different meaning* (S14).
> *Mesela o [kelime] renkli olmasaydı… O kelimeyi yanlış bir kelime okuyabilirdik. Ya da şöyle o kelimeyi biz başka anlamda okuyabilirdik. Öyle kırmızı yazıldığı için orada başka anlama geldiğini anladım* (S14).

> *For example, I understood that the word is not a pure substance because it is written in red* (S5).
> *Mesela saf madde olmadığını onun [kırmızı ile yazıldığı] için anladım (S5).*

4.1.3.3 Interface Design

a. Simple Design

Design Principle: "The material should have a simple design."

The interviews conducted with the LD students (n=10) revealed that they did not have any problem while using the online learning material and they want to use the material to learn new words later.

b. Font Type / Size

Design Principle: *"The material should allow students to customize appropriate font size/ type for themselves."*

In the implementation & evaluation phase, all of the students customized the material for themselves. They all chose an avatar and dressed it with accessories such as glasses and a hairclip. Then, they selected the font type and size they could read easily. Finally, all students selected a background color they liked.

c. Scroll bar

The observation in the implementation & evaluation phase showed that more than half of the students (*n= 9*) did not realize the scroll bar. There is a scroll bar to see the whole text in the online learning material. Yet, most students did not see the scroll bar

and tried to pass the screen without reading the whole text. The researcher had to warn students to read the rest of the text. Thus, there should be a warning message if students do not use the scroll bar while reading the text.

4.1.3.4 Practice

a. Providing a chance to visit the subject screen

The design & development phase revealed that the online learning material should provide a chance to revisit the subject screen. However, none of the students used the button to go back to the related part.

b. Presenting information cumulatively

Design Principle: "The material should present the information cumulatively."

In the online learning material, the information is provided cumulatively. There is a screen presenting all examples of the target words. For example, it includes the visuals of the word "pure substance." All students examined the examples and the visuals. Some of the students even repeated the word after vocalizing it. Besides, there is a screen covering all the target words and their definitions. The screen allows students to practice the definitions before reading the text. It is not obligatory, but more than half of the students (n=7) studied the words and their meanings before reading the text.

4.1.3.5 Feedback

a. Providing immediate feedback

Design Principle: "The material should provide immediate feedback."

The interview findings revealed that getting immediate feedback is important for the students. One of the students expressed her thoughts as follows:

> *When I choose the wrong answer, it tells me right away. It would be bad if it did not warn me because I would select the wrong answer by assuming it was correct* (S12). *Yanlış seçtim mi hemen söylüyor… Söylemezse o zaman kötü oluyor. Yani ben de doğru sanıp yanlış yapıyorum.* (S12)

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Observation notes also showed that students liked getting immediate feedback. Recognizing their answers were correct further motivated them.

b. Providing results as a graphic

Design Principle: "The material should provide results in a graph."

The online material has two screens where students can see their results in a graphic. One of them is designed for the vocabulary test, and the other is for the reading comprehension test. In the implementation & evaluation phase, all students checked the screens for their correct and wrong answers.

c. Giving students a chance to review the questions and their answers

Design Principle: "The material should allow students to review the questions and their answers."

The students had a chance to review their answers and the questions for vocabulary and reading comprehension tests. In the material, when clicking the review button, students can see their right and wrong answers. Eight students reviewed their results on the vocabulary test, and four reviewed their answers on reading comprehension tests. Even some students attempted to explain why they answered some questions wrong when seeing the correct answers.

4.1.4   Refinement of the principles

Principles for Selecting Content

Teaching Vocabulary

- Vocabulary teaching should be promoted with visuals.
- Vocabulary teaching should be supported with videos.
- The word to be taught should be used in a sentence to promote vocabulary teaching.
- A simple definition of the word should be provided while teaching vocabulary.
- A text covering the words to be taught should be provided to promote vocabulary teaching.

Text

- The texts to be used in the material should be appropriate for the grade level.
- The words to be taught should be appropriate for the grade level.
- Unknown words in the texts should be restricted.

Principles for Instructional Design

Multisensory Material
- The material should appeal to multiple senses.
  - o Vocabulary teaching should be promoted with visuals.
    - ▪ The visuals to be used in the material should be big and clear enough to be understood.
    - ▪ The visuals to be used in the material should be real/ daily-life oriented.
    - ▪ The visuals to be used in the material should be real photos.
    - ▪ The visuals should be supported with a text to promote understanding.
    - ▪ The material should provide example and non-example visuals for target words.

- o Vocabulary teaching should be supported with videos.
  - ▪ The videos/animations to be used in the material should focus on what to teach.
- o Vocabulary teaching should be supported with audio.
  - ▪ The audio to be used in the material should include a rising/falling intonation.
  - ▪ The audio to be used in the material should not be mechanical.

Instruction

- The material should provide instructions to tell students what to do.
- The instructions to be provided in the material should be short, clear, and stepwise.

Highlighting

- The material should highlight target information/words to be taught.
- The material should highlight the selection area.

Interface Design

- The material should be designed with contrasting colors.
- The material should allow students to customize font size/type for themselves.
- Soft background colors should be used while designing the material.
- The material should have a simple design.
- The material should provide information about the buttons used throughout the material.
- The design of the material should be consistent.

Practice

- The material should provide a chance to practice target words.
- The material should present the information cumulatively.
- The material should provide more interactions than texts in the practice part.
- The material should offer a chance to revisit the subject screen.
- The material should provide a chance to go back to the last screen
- The practice part should be designed in a simple-to-complex structure.

Feedback

- The material should provide feedback.
- The material should provide immediate feedback.
- The material should provide transition screens for students.
- The material should allow students to review the questions and their answers.
- The feedback should be designed in a way keeping the flow of the practice.
- The material should demonstrate appropriate visuals for the feedback.
- An appropriate tone for the feedback should be considered in the material.
- The material should provide results in a graph.
- The material should provide no mechanical feedback.

4.2 Effects of the Online Learning Material on Vocabulary Scores

RQ2: Does the developed online learning material affect the vocabulary scores of LD students?

This question was attempted to be settled using Wilcoxon signed-rank to compare the students' pretest and posttest vocabulary test scores. Moreover, the students were recruited for a series of interviews at the end of the study.

The findings revealed a statistically significant difference between the students' pretest (Median = 3) and posttest scores (Median = 8), z= 3.10, $p < 0.05$, with a larger effect size ($r = .61$).

Table 26. The pretest and posttest vocabulary test scores

	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	0	.00	.00	3,10	0,002
Positive Ranks	12	6.50	78.00		
Ties	1				
Total	13				

Following the study, the researcher conducted interviews with the students. The findings showed that twelve students remembered the words they had acquired in the

online learning material. Moreover, all students (n=13) reported noticing target words in the reading comprehension text.

4.3 Effects of the Online Learning Material on Reading Comprehension Scores

RQ3: Does the developed online learning material affect the reading comprehension scores of the LD students?

Another Wilcoxon signed-rank test was performed to compare the students' pretest and posttest reading comprehension scores. The results demonstrated a statistically significant difference between their pretest (Median = 5) and posttest reading comprehension scores (Median = 8), $z = 3.06$, $p < 0.05$, with a large effect size ($r = .60$).

Table 27. The pretest and posttest reading comprehension test scores

	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	1	2.00	2.00	3.06	0,002
Positive Ranks	12	7.42	89.00		
Ties	0				
Total	13				

The findings of the interviews held following the study showed that nearly all the students (n = 12) reported that learning target words before the reading session helped them understand the text better:

> *The material taught me the words at first. Then, I answered the questions related to the words correctly… I no longer confuse the words pure substance and mixture. I was confused about them, but now, I am not.* (S13)
> *[Materyal] İlk başta [kelimeleri] öğretti. Sonra ben onları [kelimelerle ilgili soruları] doğru cevapladım… Eleme ve saf maddeyi artık karıştırmıyorum. Daha demin karıştırdım ama şimdi karıştırmıyorum.* (S13)
>
> *Studying the words first helped me learn and gain knowledge (*S15).
> *[Kelimeleri önce çalışmak] Hem öğrenmemi sağladı hem de bilgi kazandırdı.* (S15)
>
> *Learning the words at the beginning helped me understand the text. (*S6*)*
> *[Kelimeleri başta öğrenmenin metni] anlamama faydası oldu.* (S6)

If I had not known the meaning of the words I learned in the material, then I would not have been able to understand the text. I could not answer the questions either. (S14)
Öğrendiğim kelimelerin anlamlarını bilmeseydim o zaman metni anlayamazdım. Soruları da çözemezdim. (S14)

I could read the text faster and understood it better. (S5)
Metni daha çabuk okudum. Daha iyi anladım. (S5)

Learning the words at the beginning made it easier for me to read the text... I understood it more easily. (S7)
[Kelimeleri başta öğrenmek metni okumamı] kolaylaştırdı... Daha rahat anladım. (S7)

I think I read the text easily... I learned the words. The text explained them in detail, and I could answer the questions easily. (S10)
Bence kolay okudum [metni]... O kelimeleri öğrendim. Metinde de o kelimeleri iyice anlattı ve soruları daha kolay cevaplayabildim. (S10)

4.4 Findings on the Opinions of Teachers and Academicians

RQ4: What are the opinions of special education teachers and academicians about the materials and current use of technology to support the reading comprehension of LD students?

The researcher interviewed seven special education teachers and four academics in the analysis phase to uncover their problems and needs in terms of materials and their experiences with technology usage in education. The findings revealed two main themes: material, and the use of technology for the research question 4. Table 28 present the themes, categories and subcategories.

Table 28. Themes emerging in the analysis phase for RQ4

Themes / Categories / Subcategories
A. Material
1. Lack of material
2. Need for material variety
3. Need for multisensory materials
4. Need for materials specifically designed for children with LD
B. The use of technology
1. Importance of use of technology
2. Lack of technical infrastructure and devices
3. Positive effects of use of technology
a. Facilitating teachers' work
b. Providing flexible time
c. Providing independent study
d. Providing practice needed

4.4.1 Material

Material is among the themes emerging in the analysis phase, and Table 29 presents the categories of the theme material: lack of material, need for material variety, need for multisensory materials, and need for materials specifically designed for LD children.

Table 29. Categories of the theme material

Category	n
1. Lack of material	8
2. Need for material variety	4
3. Need for multisensory materials	4
4. Need for materials specifically designed for LD children	2

4.4.1.1 Lack of Material

The findings generally pointed out a lack of material to be utilized for learning disabilities. Eight participants reported not having sufficient materials in their classrooms:

> *Obviously, I need extra materials because the time is limited to prepare them* (SET1). *Ekstra materyale evet ihtiyacım oluyor açıkçası çünkü dediğim gibi [materyal hazırlamak için] zaman kısıtlı* (SET1).

I do not think that it is enough ... When it comes to materials for LD students, one may usually count texts for reading-writing activities. The materials are only limited to the ones I mentioned (SET2).

Ya yeterli olduğunu aslında düşünmüyorum... Özel öğrenme güçlüğü olan öğrenciler için genelde materyal denince aklımıza, işte örnek veriyorum okuma yazma da işte okuduğunu anlama metinleri geliyor. Bunlarla sınırlı kalınmış (SET2).

Our current materials obviously remain inadequate. (SET3).
Şu an kullandığımız materyaller yeterli değil açıkçası. (SET3).

... existing books and other materials are designed for TD students, and I need to introduce something new to LD students (SET4).
... var olan kitap vs. kullanmak yani bunların hepsi normal öğrenciler için tasarlanmış şeyler ve benim üstüne bir şeyler katmam bir şeyler eklemem gerekiyor (SET4).

4.4.1.2 Need for Material Variety

Four teachers claimed a need for material variety to support the learning of their LD students: The participants disclosed their opinions as follows:

For example, even a chalkboard creates a difference. In other words, the student does not want to write with chalk. A whiteboard would attract more attention from them. A smartboard would even appeal to them more...Using something different would motivate students more (SET2).

Örnek veriyorum, şu tebeşir tahtası bile fark ediyor. Yani tebeşirle yazmak istemiyor öğrenci ama burada mesela normal kalemli bir tahta olsa daha çok ilgisini çekiyor. Akıllı tahta olsa daha çok ilgisini çekecek... O [farklı bir şey kullanıyor olmak] onu daha çok motive ediyor (SET2).

Of course, different materials would attract students' attention more (SET7).
Ya tabi daha farklı şeyler [materyaller] olursa, öğrencinin daha fazla ilgisini çeker (SET7).

4.4.1.3 Need for Multisensory Materials

According to the findings, four participants reported a need for multisensory materials:

Materials can include visuals. Sometimes there are problems related to students' pronunciation. It can include sound... Materials covering both visuals and sounds can be prepared (SET3).

Görsellerin fazla olduğu [bir materyal olabilir]. Bazen işte çocukların söyleyiş şeyleri de işte artikülasyonlarından dolayı sıkıntıları oluyor. [Materyal] sesli olabilir ... Hem görsel hem sesli olabilecek bir materyal işte hazırlanabilir (SET3).

Yes, I think using technology-based materials would be rather beneficial because they appeal to more senses of the students and help the permanence of knowledge among them. (SET4).

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Yani evet bunun [teknoloji tabanlı materyal] kullanımının çok yararlı ve faydalı olabileceğini düşünüyorum. Çünkü ne kadar çok duyuya hitap edersek o kadar çok kalıcılık artıyor. (SET4).

I think materials should provide students with much more stimuli and related components. (A4).
Materyalin çok daha fazla uyarana, çok daha fazla ilgili bileşene doğru çocuğu götürmesi gerektiğini düşünüyorum. (A4).

4.4.1.4 Need for Materials Specifically Designed for LD Children

Two participants stated a need for materials specifically designed for LD students:

It is obvious that technology can support learning within the school through smart boards, etc. Unfortunately, they are not fully deployed…However, there must be materials specifically designed to be used on smart boards (SET2).
Ya [teknolojinin] okul içerisinde {öğrenmeyi} desteklediği ortada ki zaten hani ülkemizde çalışılan bazı şeyler var işte bu akıllı tahtalar şunlar bunlar. Hani maalesef onlar tam anlamıyla kullanılamıyor … O akıllı tahtada uygulanabilecek bir şeylerin olması gerekiyor (SET2).

I try to generate materials for students at home because existing books and other materials are designed for TD students, and I need to introduce something new to LD students (SET4).
Öğrenciler için evde kendim biraz materyal tasarlamaya çalışıyorum. Çünkü var olan kitap vs. kullanmak yani bunların hepsi normal öğrenciler için tasarlanmış şeyler ve benim üstüne bir şeyler katmam bir şeyler eklemem gerekiyor (SET4).

4.4.2 The Use of Technology

The use of technology is the second theme emerging as a result of the interviews. The categories and sub-categories pertaining to the theme use of technology are presented in Table 30.

Table 30. Categories and sub-categories of the theme use of technology

Category / Sub-category	n
1. Importance of the use of technology	5
2. Lack of technical infrastructure and devices	5
3. Positive effects of the use of technology	
a. Facilitating teachers' work	4
b. Providing flexible time	3
c. Offering independence	2
d. Providing practice needed	2

4.4.2.1 Importance of Use of Technology

In the analysis phase, five participants expressed that using technology in special education benefits the students learning process:

> *So, yes, I think the use of technology would be rather helpful (SET4).*
> *Yani evet bunun [teknoloji] kullanımının çok yararlı ve faydalı olabileceğini düşünüyorum (SET4).*
>
> *I definitely think that the use of technology would be beneficial (A3).*
> *[Teknoloji kullanımının] faydalı olabileceğini düşünüyorum kesinlikle (A3).*

4.4.2.2 Lack of Technical Infrastructure and Devices

In the analysis phase, five teachers reported a lack of infrastructure and devices in their schools:

> *No, unfortunately. We have to bring our laptops or tablets to our classrooms. There are no technical devices, such as computers, projectors, or tablets, to use in the school (SET1).*
> *Hayır, maalesef. Ya buraya [sınıfa] kendi kişisel laptoplarımızı ya da tabletlerimizi getirmemiz gerekiyor. Başka bir şekilde okul içerisinde teknolojik bir alet kullanımı ya da işte bilgisayarı getirip sınıfa kuralım ya da projeksiyon kullanalım ya da tabletimiz varda onu alıp getirelim gibi bir imkânımız yok şu an (SET1).*
>
> *Let's pretend that the student did not know the word "board." If I cannot help students understand the word by explaining it, I try to visualize it. I show its picture from my tablet. However, I have nothing to teach vocabulary further to students other than those I mentioned. I am limited to them (SET2).*
> *Örnek veriyorum işte tahta. [Öğrencinin] Bunun anlamını bilmediğini varsayalım. Anlatarak eğer bunu çözemiyorsak bunu görselleştiriyorum... Ne bileyim tabletten [kendi tabletinden] işte resmini gösteriyorum... Ama onun [kendi tableti] dışında başka bir şeyiniz var mı derseniz ne yalan söyleyeyim yok. Onunla kısıtlı kalıyorum (SET2).*
>
> *Our institution is not technologically equipped. In general, no rehabilitation center has technological devices (SET4).*
> *Teknolojik olarak çok donanımlı bir kurumumuz yok. Genel anlamda hiçbir rehabilitasyon merkezinde böyle çok teknolojik olarak donanımlı şeyler yok" (SET4).*

4.4.2.3 Positive Effects of the Use of Technology

In the analysis phase, the participants also mentioned the positive effects of the use of technology in special education. Facilitating teachers' work, providing flexible time,

offering independence, and providing practice needed for the students are among the positive effects mentioned by the teachers and the academics, as seen in Table 31.

Table 31. Subcategories of positive effects of the use of technology

Category / Sub-category	n
Positive effects of the use of technology	
a. Facilitating teachers' work	4
b. Providing flexible time	3
c. Offering independence	2
d. Providing practice needed	2

b. Facilitating teachers' work

In the interviews, four participants explained that the use of technology could relatively facilitate their work:

> *It also offers ready-made materials to a teacher. The teacher can perform vocabulary teaching more practically instead of searching for visuals.* (A2)
> *Hem de hazır materyal sunmuş olur aslında öğretmene de çünkü hani o anda açacak görseller bulacak bir şeyler yapacak. Onun yerine çok daha pratik bir şekilde kelime öğretimine yer verebilir.* (A2)

> *When the child encounters a word that they do not know its meaning, they can see its usage in different sentences [in a technology-based material]. Thus, they can get its meaning instead of teachers using it in sentences.* (A3)
> *Söz konusu sözcüğü öğretmen farklı cümleler içerisinde kullanmak yerine çocuk anlamadığı bir sözcükle karşılaştığında bu sözcüğe ilişkin farklı cümleler içerisinde kullanımını [teknoloji tabanlı materyal içerisinde] görüp şey yapabilir [anlayabilir].* (A3)

> *It will be much easier for them to teach vocabulary using such a program [technology-based material] ...* (A4)
> *Böyle hazırlanmış bir programla [teknoloji tabanlı bir materyal] birlikte bir kelime öğretimini gerçekleştirmek onlar [öğretmenler] için çok daha kolay olacaktır…* (A4)

c. Providing flexible time

The other positive effect of the use of technology was to provide teachers with flexible time in their work. Three participants argued that the use of technology provides flexible time for students while studying. One of the participants explained that:

The Turkish language course already takes a 45-min class. When it comes to improving their vocabulary, this 45-minute class remains insufficient, and vocabulary teaching needs to be divided into weeks. For this reason, if we have technological stuff, it will be much better (SET1).

Aldıkları Türkçe modülü dersi zaten 45 dakikalık bir ders. Kelime dağarcığını geliştirmeye yönelik bir çalışmaya başladığınız zaman da o 45 dakikalık süre zaten yetersiz kalıyor ve çok fazla haftalara bölünmesi gerekiyor. O yüzden teknolojik bir şey elimizde olursa, bir program elde olursa çok daha iyi olabiliyor (SET1).

d. Providing independent study

Two of the participants declared that the use of technology allows students to study independently:

Of course, technology is essential for children to study independently (A1).
Tabi [çocukların] bağımsız çalışması açısından [teknoloji] çok önemli (A1).

When it comes to technological tools, they become a helpful resource that children can use independently from the teacher... It enables children to study independently (A3).
Teknolojik araçlar işin içine girdiği zaman hani bir ödev gibi öğretmenden bağımsız olarak da çocukların kullanabileceği bir kaynak sağlayacak sonuçta bu bize... Bağımsız çalışmasını sağlayabilir (A3).

e. Providing practice needed

In the analysis phase, two participants asserted that the use of technology gives students a chance to do necessary practices:

The use of technology allows the child to do the practice. The child can make practice as many times as they want (A2).
[Teknoloji kullanımı] hem tekrara da izin verebilir. Çocuk istediği kadar onu [materyali] tekrar edebilir (A2).

The child can do the practice on their own [by using technological tools] (A3).
[Teknolojik araçları kullanarak] kendine başına pratik yapılabilir (A3).

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter presents a discussion of the findings according to research questions, research implications researchers, implications for practitioners, recommendations for future research, and limitations.

5.1   Principles for Designing an Online Learning Material

Learning Difficulty (LD) is a lifelong problem, but its adverse effects can be reduced with the help of customized materials (Rief & Stern, 2010). Thus, it is necessary to design and develop learning materials by considering the needs of LD students, teachers, and learning environments (Çağıltay et al., 2019), which seems only possible by following situation-specific principles upon collaborations with stakeholders, as Design-Based Research (DBR) highlights (Richey & Klein, 2005). Therefore, the study aimed to determine principles for designing an online learning material to promote LD students' reading comprehension performance by working collaboratively with stakeholders. According to the findings, the emerging principles were grouped under two main themes: principles for selecting content and principles for instructional design. The following sections discuss the findings of the mentioned themes.

5.1.1   Principles for Selecting Content

The results revealed two main categories for the principles of selecting content: vocabulary teaching and text. The first category is further divided into five sub-categories: using visuals, using video, using the word in a sentence, providing a simple definition, and using a text covering the words.

Firstly, the findings emphasized supporting vocabulary teaching by *using visuals* to concretize target words (Doğanay-Bilgi, 2017) and facilitate learning (Fletcher &

Tobias, 2005). Moreover, the outcomes highlighted *using videos* to promote the learning of new words (Carlisle et al., 2021). Further, the results revealed that *the words should be used in a sentence*. Thus, students can recognize how target words can be used in a sentence (Özbay & Melanlıoğlu, 2008) and get their different meanings (Nelson & Stage, 2007). The findings also pointed out that *providing a simple definition of the word* may be critical for students' understanding (Carlisle et al., 2021) since providing a dictionary definition might include more unknown words, which adversely affects students' understanding of the target word. Finally, the findings revealed that students could have a chance to get the different meanings of target words when encountering *texts covering target words*. As a result, vocabulary teaching-related principles could assist students' vocabulary acquisition thanks to giving students a chance to experience target words in diverse ways: visuals, videos, sentences, simple definitions, and texts. The principles may also improve students' reading comprehension and vocabulary performance upon providing preliminary knowledge about the text.

The second category has three sub-categories. Firstly, the results revealed that *using a grade-level text* is important for teaching vocabulary (Özbay & Melanlıoğlu, 2008) and supporting reading comprehension (Westwood, 2016). Using inappropriate texts could result in difficulty in comprehension and learning. The outcomes also demonstrated that *the text should include grade-level words* and *restrict unknown words*. Lexical capacity is a fundamental element for effective reading comprehension (Duke et al., 2011); thus, restricting unknown words in a text may promote reading comprehension. In the current study, the texts and words were decided collaboratively with subject matter experts to make them appropriate for LD students (Plomp, 2013). Therefore, using appropriate texts/words and restricting unknown words might positively affect students' performance.

5.1.2 Principles for Instructional Design

The study's findings revealed six main categories for instructional design principles: multisensory material, instruction, highlighting, interface design, practice, and

feedback. The principles that emerged from the categories and sub-categories are discussed below.

Multisensory Material

The "Multisensory Material" is the first category and has three sub-categories: using visuals, using videos, and using audio. The findings showed that "*the material should appeal to multiple senses*" since multisensory materials could help LD students keep their attention (Westwood, 2016) and facilitate the retention of knowledge (Hudson, 2016; Massey, 2008) by addressing different senses (Özmen, 2017; Reid, 2007). Therefore, providing multisensory materials could be used to facilitate LD students' learning process (NRP, 2000). They give students a chance to look, listen, respond and actively participate to the learning process, which can result in better performance.

Traditional teaching methods utilize visuals, videos, and animations to support texts (Mayer, 2014; Mayer, 2005b); however, combining these elements does not always guarantee meaningful learning. Understanding how to use them together is crucial to maximizing learning (Mayer, 2005a; Mayer & Moreno, 2003). The present findings yielded more detailed principles, which may guide practitioners while developing their materials about how to use and select visuals, videos, and audio to promote learning.

Firstly, the results showed that *vocabulary teaching should be supported with visuals*. Using visuals is considered essential since helping students concretize verbal information (British Dyslexia Association, 2018; Doğanay-Bilgi, 2017) and facilitates learning (Fletcher & Tobias, 2005). According to Dual Coding Theory (DCT), there are two main information processing systems which are verbal and visual. The use of verbal and nonverbal (pictorial) codes together can contribute to recall. Moreover, combining verbal elaboration, pictures, and mental imagery is more effective in enhancing comprehension of a text and learning (Clark & Paivio, 1991). In line with DCT, Mayer (2005b) also recommends the use of related words and visuals together rather than words alone (Mayer & Anderson, 1992). The findings showed that students benefited from visuals. They expressed in the interviews that using visuals help them to remember the words and understand the meaning easily.

The results also revealed specific principles for using and selecting visuals in the material. Accordingly, the visuals to be used in the material should be _big and clear enough to be understood_. The visuals should be _real/daily-life oriented_ to help students relate them to their lives. Moreover, the principles illustrated that _visuals should be supported with texts to promote understanding_. As the contiguity principle highlights, using words and visuals contiguously encourage students to build connection between them (Mayer & Anderson, 1992). Furthermore, the material should provide _example and non-example visuals of the word_ to reinforce the acquisition (Carlisle et al., 2021). According to the literature, providing illustrative examples promotes learning of the concepts by disambiguating how knowledge can be exemplified in real-word settings (Rawson et al., 2015).

Secondly, the results highlighted that _vocabulary teaching should be supported with videos_ (Carlisle et al., 2021). However, _videos should focus on what to teach_ to direct students' attention to the relevant information and promote understanding (Mayer & Moreno, 2003). In other words, the material should exclude extraneous information to help the learner to learn more deeply.

Thirdly, findings revealed principles related to _supporting vocabulary teaching with audio_. The result demonstrated that the _audio to be used in the material should include a rising/falling intonation_ to direct students' attention to the relevant information and help them not miss any information. LD students often experience attention problems (Lawrence, 2009); thus, their focus needs to be kept on the relevant information to foster their learning (Westwood, 2016). The principles could contribute to students' learning by directing their attention to the relevant information (Mayer & Moreno, 2003) and excluding irrelevant information (Mayer, 2005c). The observation notes showed that students who used the audio button to vocalize text accompanied the voice and imitated the intonation. For example, when they vocalize the sentence belongs to non-example visual, they especially imitate the intonation of audio "we cannot" and shake their heads to confirm it.

Besides, the results illustrated that the _audio should not be mechanical_. Advanced technologies provide a chance to vocalize a text; however, a human voice is preferable

since a computer-generated voice could be more mechanical (Mayer, 2020). Although supporting vocabulary teaching with audio is important, not all students used the audio button. Students who have lower fluency levels vocalized the texts by using the audio button. On the other hand, students who have higher reading fluency level did not use the audio option since they can read the text themselves easily.

The principles, which were obtained from a series of design and development cycles with the teachers, students, and academics, may guide practitioners when developing their materials for LD students. Moreover, the present principles can contribute to students' reading comprehension and vocabulary performance in an expository text since they all especially consider and are based on LD students' needs and characteristics.

Instruction

"Instruction" is the second category under the theme principles for instructional design with two sub-categories: *the material should provide instructions to tell students what to do"* and *"the instructions in the material should be short, clear, and stepwise"* According to results, providing short, clear, and stepwise instruction is important for LD students because they have problems following and remembering long instructions (British Dyslexia Association, 2018; Özmen, 2017; Reid, 2005). The design of the online learning material aims to give students a chance to make practice individually without the supervision of anyone. For that reason, the material guides the students about what they are supposed to do. Thus, determining how to provide instruction in the online learning material is critical to support students' independent study.

Highlighting

"Highlighting" is the third category of the theme principles for instructional design and pointed out that "*the material should highlight target information to be taught and selection area.*" The findings illustrated that keywords in the definitions and negative phrases should be highlighted to direct students' attention to the critical information (Westwood, 2016). Moreover, the buttons and the boxes should be highlighted with different colors (Doğan, 2015; Mayer, 2017) to show students what they would select.

Directing students' attention to the essential parts of the target information would help students to avoid processing extraneous material (Mayer, 2005c) and results in deeper learning (Jeung et al., 1997; Moreno, 2007). The principles related to highlighting are critical because both aims to direct students' attention to the essential parts to help them not miss anything important. The interview results also showed that LD students benefited from highlighting. They expressed in the interviews that writing words in different color directed their attention to the key points. If the words were not highlighted, they may not notice them.

Interface Design

"Interface Design" is the fourth category with six sub-categories related to colors, font type, simplicity, and material consistency. First, the results revealed that *contrasting colors* should be preferred while designing the material to increase the visibility and readability of the presented information (British Dyslexia Association, 2018; Carlisle et al., 2021). Moreover, *soft background colors* should be elected to make students feel more comfortable while reading (British Dyslexia Association, 2018). The online learning material in this study offers different soft background colors, and students can choose the one they feel more comfortable reading the texts (British Dyslexia Association, 2018; Evett & Brown, 2005).

Furthermore, the findings highlighted that the learning material should allow students to *customize font type and size*. The learning material offers four different font types: Arial, Verdana, Comic Sans, and Calibri and three different font sizes: 12-16 pt. Allowing students to select the appropriate font type and size seems important because each could prefer a different type and size while reading (British Dyslexia Association, 2018). Font type and size are important elements affecting reading comprehension accordingly learning in a text. Therefore, it is critical to offer students options in the material to help them customize the material according to their needs. Also, the results of the current study showed that all students customized material for themselves by selecting font type, size and background color. They tried the options for the font type, size and colors and selected the one they want.

Besides, the findings demonstrated that *the material design should be simple* and *consistent*. Providing a simple design and consistency allow students to study the target information independently. When students learn and adapt to how the material works, they may not need supervision. In other words, the simpler and more consistent the material is, the easier it can be used. For example, providing background pictures or patterns might seem tempting but could distract students' attention (British Dyslexia Association, 2018). The interview results showed that students (n=10) did not have problems while using the online learning material. They also want to use the material to learn new words. Finally, the results implied that *providing information about the buttons* is necessary since it could help students use the material themselves without any help. Designing a learning material that is user-friendly can help students focus on the learning process rather than spending time and energy on how to use it.

Practice

"Practice" is the sixth category with six sub-categories. Firstly, the results emphasized providing a chance to practice the target words because LD students need to practice the newly learned knowledge to keep it in their long-term memory (Lawrence, 2009; Özbay & Melanlıoğlu, 2008; Reid, 2007). Practice is an essential instructional element in helping students transfer their knowledge (Çağıltay et al., 2019); thereby, one may need to consider its design. While using the online learning material, students could practice the words and get immediate feedback. In the practice part, there was a mini test that students were asked to answer. The literature shows that taking tests can help students in retrieving the information that they engage by determining the gaps in their knowledge, and relate their existing knowledge to the new contexts (Roediger et.al., 2011). LD students need to practice what they learn so how to design a practice part in the learning material is critical. The findings of the study revealed detailed principles which can be an answer for the question how to design practice part by considering the needs and characteristics of LD students.

The sub-categories revealed that the practice area should be designed as *interactive*. It should allow students to interact with the material instead of just reading texts. Furthermore, the practice area should be designed with a *simple-to-complex structure*.

The activities in the practice area should also be presented progressively. For example, the number of examples may increase in the subsequent activities. In addition, the practice area should allow students to *revisit the related subject part* when needed and *return to the last screen*. The participants explained that giving students a chance to return to the subject could contribute to their learning. However, observation results showed that none of the students used the related button to revisit the subject part.

Additionally, the results showed that *the material should provide information cumulatively*. The material shows target words with many visuals. A screen presenting all visuals related to the target word at the end of each dictation would reinforce students' learning (Özbay & Melanlıoğlu, 2008). Moreover, the material hosts a screen presenting all the words and their definitions before text reading. These screens aim to provide a chance to practice what students have learned. In other words, the material presents information on different screens cumulatively to create a holistic sense. According to observation results, the students examined the screens providing the information cumulatively. They (n=13) examined grouped visuals, and the definition of the words they want to know (n=6). The elaboration theory highlights presenting information progressively by elaborating on earlier ones (Reigeluth &Stein, 1983). Accordingly, the simplest version of knowledge is presented to the students. Then, the information should be reminded in each additional course until the whole knowledge is taught. This reminder can be form of exemplification or synthesis (Reigeluth, 1987).

Feedback

"Feedback" is the last category of the theme principles for instructional design. The sub-categories revealed nine principles about providing immediate feedback, presenting transition screens, and using appropriate tone of language/visuals while designing feedback, giving a chance to review questions and answers, providing results in a graph, and keeping the flow of practice.

Feedback is an essential instructional element (Çağıltay et al., 2019). The principles could provide hints on how to design feedback for LD students. To begin with, the results demonstrated that *the material should provide immediate feedback* because it

eliminates inaccurate practices (Vaughn et al., 2012) and increases students' motivation (Özmen, 2017). The interview and observation findings also revealed that students liked to get immediate feedback. They expressed that knowing whether or not their answers are wrong / correct right away is important for them to not make mistakes. Moreover, outcomes revealed *appropriate tone of language and visuals* should be used while designing feedback. Using any inappropriate words or visuals may demotivate students or result in misunderstanding.

Furthermore, the findings illustrated that *the material should allow students to see their results in a graph* and *review the questions and their answers* to promote their learning and assess their own progress. The outcomes revealed that most of the students examined their results from the graph and they review their answers. Also, some of the students examined their mistakes and wanted to attend the test again to get higher score. Additionally, the results uncovered that *feedback should be designed in a way of keeping the flow of practice*. In other words, the feedback should not distract students' attention. Feedback may be considered an integral part of the instruction to contribute to students' learning.

In addition, the results showed that *the material should provide transition screens* that provide cues to alert students for the next tasks and give them feedback about their progress (Carlisle et al., 2021). A transition screen may prepare learners for the following tasks and help them to focus their attention. In the implementation & evaluation phase, students noticed the transition screens and provided feedback for themselves, like "I finished two words, now I will learn the word sieving. Then, I have one more word." Elaboration theory focuses on organizational strategies for the content provided in the instruction. It prescribes how to sequence the subject matter from simple-to-complex to raise students' awareness of the content and different ideas taught (Reigeluth & Stein, 1983).

5.2 Effects of the Online Learning Material

The current study also sought the impacts of the online learning material on students' reading comprehension and vocabulary test scores. In a one-group pretest-posttest

design, the findings revealed that the online learning material had a significant effect on students' reading comprehension and vocabulary performance from pretests to posttests.

Overlapping with the present findings, the literature showed that the use of technology has significant effects on LD students' reading comprehension (Ciullo et al., 2015; Cullen et al., 2014; Floyd & Judge, 2012; Hall et al., 2015; Twyman & Tindal, 2006; Xin & Rieth, 2001; Wade et al., 2010; White & Robertson, 2015). Moreover, the previous research demonstrated a significant effect of technology use on students' vocabulary acquisition (Kennedy et al., 2015; Kennedy et al., 2014).

The online learning material is multisensory, flexible, and individualized to meet the diverse needs of students. For example, the students had a chance to customize the font type, size, and background color that are thought to affect their reading performance accordingly their learning by considering their needs. Moreover, the material supports target verbal information with visuals, videos, and audio. Providing a variety of media could help students to keep their attention and promote their learning. To illustrate, students with low reading fluency level vocalized the texts by using the audio button. They expressed that vocalization help them to read and understand better. Furthermore, the material allows students to practice what they have learned with immediate feedback by taking their time. This can contribute to reinforce the newly learned knowledge. The abovementioned could be why the online learning material significantly affected the students' reading comprehension and vocabulary performance. However, due to time limitations, the tests were conducted just after students used the online learning material. It could also be a reason to find a significant improvement in students' test performance.

The study aimed to design and develop an online, multisensory, flexible, and individualized learning material with specific stakeholders to meet the needs of LD students. Thus, the findings revealed once again that technology could promote students' reading comprehension and vocabulary performance if designed considering the needs of LD students, teachers, and learning environments.

5.3   Opinion of Special Education Teachers and Academicians

The findings of the current research emerged two main categories for the opinions of the special education teachers and academicians about the material and the current use of technology to support reading comprehension of LD students. The categories were material and the use of technology. In line with the literature, the results demonstrated that there is a lack of material to support LD students' reading comprehension. The current materials such as texts are not enough for this purpose. There should be material variety to meet diverse needs of students (Brodin, 2010; Çağıltay et al., 2019; Reid, 2009). Moreover, the outcomes showed that there is a necessity for materials which are multisensory (Hudson, 2016) and designed specifically for LD students by considering their needs (Çağıltay et al., 2019; Polat et al., 2012).

Overlapping with the literature, the interview results revealed teachers and academicians agreed on that the use of technology to support learning process is important (Chang et al., 2011; Drigas & Ioannidou, 2013). However, the interviewees explained that there is lack of technological devices and infrastructure in the schools. Nevertheless, the participants think that the use of technology has positive effects such as facilitating teachers' job, providing flexible time, independency (Carter, 2005; Jitendra & Gajria, 2011) and practice needed for the students (Kaur et al., 2017; Massey, 2008).

5.4   Implications of the Study

This study aimed to determine the design principles of an online learning material designed to support LD students' reading comprehension and vocabulary acquisition. The fundamental issue was to design and develop the most appropriate and effective learning material to meet the diverse needs of LD students. Thus, it was essential to include all stakeholders in the design and development processes of the material and gather their recommendations throughout the study. Including stakeholders in the phases, from analysis to implementation & evaluation, could ensure achieving the most appropriate material for students with LD. While including various stakeholders

is one of the most critical impacts of the study, the other possible implications can be listed as follows:

- The design principles of the study can guide other researchers and teachers aiming to design and develop their materials to promote reading comprehension performance through teaching technical vocabulary.
- The study presents a detailed methodology and findings pertaining to the material to guide researchers in carrying out and documenting similar research. They can follow the procedures explained in this study while conducting their research and reporting their findings.
- The study shed light on the opinions of several stakeholders: teachers, academics, and LD students. Therefore, the researchers can review the results from different aspects and benefits.
- This study can also help researchers to understand the effects of online learning material on students' reading comprehension and vocabulary acquisition.

5.4.1 Implications for Practitioners

The current study's possible implications for the practitioners and researchers are listed as follows:

- The online material is accessible through the internet; thus, teachers can access the online learning material easily and conveniently use it in their classes if they have an internet connection and computers in their schools.
- The results showed that online learning materials should be designed multisensory. The outcomes revealed that the students benefited from the visuals. They expressed that visuals helped them to remember the words and understand their meanings. If practitioners support their materials with visuals, they can facilitate students' learning.
- The findings presented that students with lower reading fluency levels used audio buttons to vocalize the text more when compared with the students with higher reading fluency levels. They expressed that audio helped them to read and understand the text easily. The observation notes also showed that

intonated audio directed students' attention to the relevant information, and helped them not miss negative phrases in the text. If the practitioners use intonated audio in their materials, they can facilitate the learning of students with low reading fluency levels.

- The results revealed that the online learning material should provide the opportunity of reviewing the answers and questions. In the current study, most students reviewed their answers. They got a chance to examine their performance by seeing where they did a mistake. If the practitioners provide the opportunity in their materials, they can give students a chance to examine their performance and encourage their students for better performance.

- The findings presented that the learning material should highlight the target information to be taught to direct students' attention to the relevant information. In the interviews, students disclosed that writing the keywords and negative phrases in a different color directed their attention to the words. If the words were not colored, they could not notice them. Practitioners who want to develop learning material for their students with LD should emphasize the key points to direct students' attention and not miss any critical information.

- The outcomes demonstrated that the online learning material should provide information cumulatively. The material presented visuals which are provided step by step as a whole and grouped to help students create a scheme related to the word. The observation notes also showed that all students examined the screens and their test scores increased from the pretest to the posttest. The practitioners should use such screens to provide cumulative and grouped information to help LD students understand the words better.

- The results showed that the material should provide a transition screen to give students feedback about their progress and prepare them for the next task. The findings also showed that the students who examined the transition screens obtained self-feedback for themselves, such as "I finished the word sieving, I am going to learn the word filtering" or "now I will have a test, I should focus". Practitioners who want to develop learning material for their LD students

should use transition screens to help their students focus on their learning process and prepare themselves for the coming task.

5.5 Recommendations for Future Research

The current study aimed to uncover design principles of an online learning material to promote the reading comprehension performance of LD students in an expository text through teaching vocabulary. Moreover, it investigated the effectiveness of the online learning material on their reading comprehension and vocabulary performance. Based on the findings, a few recommendations could be offered for future studies:

- The study explored for the effectiveness of online learning material for a science text. Further studies may test the design principles emerging in this study in other contexts such as in social sciences to understand how the principles will change.

- Similar studies can be conducted to determine the effectiveness of learning material, including different difficulty levels of texts and words. The current research used a medium-difficulty level text to test the principles. Different levels of text might require modification or addition to the design principles.

- In the current study, the effectiveness of the material was tested in a one-group pretest-posttest design. Prospective researchers may prefer longitudinal research to determine how the effects of the online learning material on LD students' reading comprehension and vocabulary acquisition performance change in the long run.

- Future research may recruit different groups of LD students with the same reading fluency levels to test the design principles and determine how the principles change between the groups.

- This study was conducted in a real classroom environment. However, the aim was to design and develop a learning material that can be used in and out of the school setting. For that reason, the adaptability of the online learning material to the home environment can be investigated to determine possible changes to the principles.

- In the current study, the students used laptops with a mouse and keyboard to study the online learning material. Future research may consider using touchscreen technology as an interaction type to reveal how the design principles would change since the students might have more tendency to interact with mobile devices more.

5.6 Limitations of the Study

This study is not free of a few limitations. Firstly, the study was carried out on a small sample size; there were only thirteen LD students in the study. Secondly, the findings were limited to fourth-grade LD students enrolled in a special education and rehabilitation center in Ankara. The study can be replicated with more LD students enrolled in different special education and rehabilitation centers in Ankara. Thirdly, the study was limited to the selected text "*Saf Madde ve Karışım*" and the words "*saf madde, karışım, eleme, and süzme.*" The material can be enriched with more texts and words if there is no time restriction. Also, the material can include texts with different difficulty levels to determine the effects of the online learning material on students' performance.

Lastly, the study was limited to the researcher's observations in many phases except for the pilot study. The students' teachers wanted to be included in the study, but could not due to the COVID-19 pandemic.

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APPENDICIES

A. METU Human Subjects Ethics Committee Permission Letter

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

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26 MART 2019

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Doç.Dr. Ömer DELİALİOĞLU

Danışmanlığını yaptığınız Sibel DOĞAN'ın **"Öğrenme Güçlüğü Yaşayan Öğrenciler için Mobil Bir Uygulamanın Tasarımı"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **162-ODTÜ-2019** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof. Dr. Tülin GENÇÖZ
Başkan

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Prof. Dr. Yaşar KONDAKÇI (Y.)
Üye

Doç. Dr. Emre SELÇUK
Üye

Doç. Dr. Pınar KAYGAN
Üye

Dr. Öğr. Üyesi Ali Emre TURGUT
Üye

B. The Ministry of National Education Permission Letter

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

Sayı : 14588481-605.99-E.8555322   26.06.2020
Konu : Araştırma İzni

ORTA DOĞU TEKNİK ÜNİVERSİTESİNE
(Öğrenci İşleri Daire Başkanlığı)

İlgi: a) MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2020/2 sayılı Genelgesi.
b) 11.06.2020 tarihli ve 195 sayılı yazınız.

Üniversiteniz Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü doktora öğrencisi Sibel DOĞAN'ın "**Öğrenim Güçlüğü Yaşayan Öğrenciler Için Mobil Bir Uygulama Tasarımı**" konulu çalışması kapsamında İlimize bağlı, ekli listedeki okullarda uygulama yapma talebi ilgi (a) Genelge çerçevesinde incelenmiştir.

Yapılan inceleme sonucunda, söz konusu araştırmanın Müdürlüğümüzde muhafaza edilen ölçme araçlarının; Türkiye Cumhuriyeti Anayasası, Milli Eğitim Temel Kanunu ile Türk Milli Eğitiminin genel amaçlarına uygun olarak, ilgili yasal düzenlemelerde belirtilen ilke, esas ve amaçlara aykırılık teşkil etmeyecek, eğitim-öğretim faaliyetlerini aksatmayacak şekilde okul ve kurum yöneticilerinin sorumluluğunda, gönüllülük esasına göre uygulanması Müdürlüğümüzce uygun görülmüştür.

Bilgilerinizi ve gereğini rica ederim.

Turan AKPINAR
Vali a.
Milli Eğitim Müdürü

Ek: Uygulama Araçları

Dağıtım:
Gereği: Bilgi:
ODTÜ   Çankaya, Yenimahalle, Altındağ, Etimesgut,
                                    Keçiören İlçe MEM

C. Informed Consent Form

Bu çalışma, Araş. Gör. Sibel Doğan'ın doktora tez çalışması olup, danışmanlığını Prof. Dr. Ömer Delialioğlu yürütmektedir. Bu çalışmanın amacı öğrenme güçlüğü yaşayan öğrencilerin okuduğunu anlama performanslarını arttırmak için tasarlanacak eğitsel materyalin gerekliliklerini belirlemektir. Ayrıca tasarlanan materyalin öğrencilerin performansları üzerindeki etkileri de incelenecektir.

Çalışma süreci; analiz, tasarım & geliştirme ve uygulama & değerlendirme olmak üzere üç bölümden oluşacaktır. Süreçler içerisinde özel eğitim öğretmenleri, aileler ve akademisyenler ile görüşmeler ve öğrenme güçlüğü yaşayan öğrenciler ile uygulamalar yapılacaktır. Çalışmaya katılım tamamıyla gönüllülük esasına dayanmaktadır. Belirli kişisel bilgiler dışında sizden özel bilgiler istenmeyecektir. Cevaplarınız ses kaydı olarak saklanacak, tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayınlarda kullanılacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz.

Çalışma hakkında daha fazla bilgi almak için Orta Doğu Teknik Üniversitesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü Araştırma Görevlisi Sibel Doğan (Tel: 210 7525; E-posta: sidogan@metu.edu.tr) ya da öğretim üyesi Prof. Dr. Ömer Delialioğlu (Oda: EFC-20; Tel: 210 4198; E-posta: omerd@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu projeye tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad   Tarih   İmza

           ----/----/-----

D. Parental Consent Form

Sayın Veliler, Sevgili Anne-Babalar,

Orta Doğu Teknik Üniversitesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü olarak "Öğrenme Güçlüğü Yaşayan Öğrenciler için Mobil Bir Uygulamanın Analizi, Tasarımı, Geliştirilmesi ve Değerlendirilmesi" başlıklı araştırmayı yürütmekteyiz. Araştırmamızın amacı öğrenme güçlüğü yaşayan öğrencilerin yaşadıkları problemleri, ihtiyaçlarını ve uygun öğretim stratejilerini göz önünde bulundurarak çevrimiçi bir öğrenme materyali tasarlamak ve tasarlanan eğitsel materyalin çocuğunuzun akademik performansı üzerindeki olası etkilerini incelemektir.

Çalışmanın amacını gerçekleştirebilmek için çocuklarınızın ve sizin bazı sorulara cevap vermesine ihtiyaç duymaktayız. Katılmasına izin verdiğiniz takdirde çocuğunuz ve siz çalışmaya çocuğunuzun öğrenme güçlüğü için eğitim aldığı özel eğitim ve rehabilitasyon merkezinde katılacaksınız. Sizden çocuğunuzun katılımcı olmasıyla ilgili izin istediğimiz gibi, çalışmaya başlamadan çocuğunuzdan da sözlü olarak katılımıyla ilgili rızası mutlaka alınacak.

Sizin ve çocuğunuzun verdiği cevaplar kesinlikle gizli tutulacak ve bu cevaplar sadece bilimsel araştırma amacıyla kullanılacaktır. Çocuğunuzun ya da sizin ismi ve kimlik bilgileriniz, hiçbir şekilde kimseyle paylaşılmayacaktır. Araştırma sonuçlarının özeti tarafımızdan çocuğunuzun devam etmekte olduğu öğrenme güçlüğü vakfı veya derneği aracılığı ile size ulaştırılacaktır.

Çocuğunuzun cevaplayacağı soruların onun psikolojik gelişimine olumsuz etkisi olmayacağından emin olabilirsiniz. Yine de bu formu imzaladıktan sonra hem siz hem de çocuğunuz katılımcılıktan ayrılma hakkına sahipsiniz. Katılım sırasında sorulan sorulardan ya da herhangi bir uygulama ile ilgili başka bir nedenden ötürü çocuğunuz kendisini rahatsız hissettiğini belirtirse, ya da kendi belirtmese de araştırmacı çocuğun rahatsız olduğunu öngörürse, çalışmaya sorular tamamlanmadan ve derhal son verilecektir. Şayet siz çocuğunuzun rahatsız olduğunu hissederseniz, böyle bir durumda çalışmadan sorumlu kişiye çocuğunuzun çalışmadan ayrılmasını istediğinizi söylemeniz yeterli olacaktır.

Bu çalışmayla ilgili daha fazla bilgi almak isterseniz: Araştırmayla ilgili sorularınızı aşağıdaki e-posta adresini kullanarak bize yöneltebilirsiniz.

Saygılarımızla,

<table>
<tr><td>Arş. Gör. Sibel DOĞAN</td><td>Prof. Dr. Ömer DELİALİOĞLU</td></tr>
<tr><td>Bilgisayar ve Öğretim</td><td>Bilgisayar ve Öğretim</td></tr>
<tr><td>Teknolojileri Eğitimi Bölümü</td><td>Teknolojileri Eğitimi Bölümü</td></tr>
<tr><td>Orta Doğu Teknik Üniversitesi,</td><td>Orta Doğu Teknik Üniversitesi,</td></tr>
<tr><td>Tel: (0312) 210 4183</td><td>Tel: (0312) 210 4198</td></tr>
<tr><td>E-Posta: sidogan@metu.edu.tr</td><td>E-Posta: omerd@metu.edu.tr</td></tr>
</table>

Bu araştırmaya tamamen gönüllü olarak katılıyorum ve çocuğum ....'nın da katılımcı olmasına izin veriyorum. Çalışmayı istediğim zaman yarıda kesip bırakabileceğimi biliyorum ve verdiğim bilgilerin bilimsel amaçlı olarak kullanılmasını kabul ediyorum.

Adı Soyadı: Tarih: … /… /…

İmza:

E. Interview Questions for Academicians

Üniversitede Özel Eğitim Alanında Görev Yapan Akademisyenlere Uygulanacak Görüşme Soruları

Kişisel Bilgiler:

İlk olarak sizi ve konumunuzu daha iyi tanımlayabilmek adına bazı giriş sorularıyla başlamak istiyorum.

1- Hangi üniversiteden / bölümden kaç yılında mezun oldunuz?
2- Özel eğitim alanında kaç yıldır görev yapıyorsunuz?
3- Araştırma alanlarınız nelerdir?

Görüşme Soruları

1. Öğrencilerin okuduğunu anlama becerisini geliştirmek için kullanılan pek çok yöntem bulunmakta. Bu yöntemler arasında sizin önerdikleriniz hangileri?
   a. Neden? Bu yöntemin katkıları neler?
   b. Kelime listesi oluşturma / kelime bilgisi hakkın ne düşünüyorsunuz?

2. Okuduğunu anlama becerisini geliştirmek için sınıflarda pratikte hangi materyaller kullanılıyor? Sizce yeterli mi?
   Evet;
   Bu materyaller hangi yönleriyle yeterli?
   Hayır;
   a. Ne tür öğretim materyallerine ihtiyaç olduğunu düşünüyorsunuz?
      i. Dijital multimedya materyaller (çoklu ortam materyalleri)-Ses, görsel ve metin destekli materyaller

3. Okuduğunu anlama becerisini geliştirmek için kullanılan teknolojiler ile ilgili ne düşünüyorsunuz? (Masaüstü veya tablet uygulamaları, sesi metne çeviren veya metni seslendiren yazılımlar vs)

4. Çocukların okuduklarını anlama becerilerini geliştirmek için dijital bir eğitim materyali tasarlayacağım. Bu materyali tasarlarken kelime bilgisi / kelime listesi stratejisinden faydalanacağım. Böyle bir materyal tasarlamak için ve size katkı sağlamak için ben nelere dikkat etmeliyim?
   a. Eğitsel içerik
      i. Metinlerin uzunluğu/ zorluk derecesi
      ii. Kullanılacak dil
      iii. Bilinmeyen kelimelerin öğretimi için
         1. Eş anlamlı zıt anlamlı görsel örnek cümle

   b. Görsel tasarım (ses, görsel, renkler)

c. Materyal ile etkileşim
    i. Örnek ekran
    ii. Yardım ekranı
    iii. Sistemi kullanma süresi
    iv. İpuçları verme

F. Interview Questions for Teachers

Özel Eğitim Alanında Görev Yapan Öğretmenlere Uygulanacak Görüşme Soruları

Kişisel Bilgiler:
İlk olarak sizi ve konumunuzu daha iyi tanımlayabilmek adına bazı giriş sorularıyla başlamak istiyorum.
1- Hangi okul ve bölümden mezunsunuz:
2- Özel eğitim alanında kaç yıldır görev yapıyorsunuz:
3- Daha önce hangi engel türleri ile çalıştınız:

Görüşme Soruları
1- Öğrencilerin okuduğunu anlama becerisini geliştirmek için kullanılan pek çok yöntem bulunmakta. Bu yöntemler arasında sizin önerdikleriniz hangileri? Siz hangilerini kullanıyorsunuz?
   a. Neden? Bu yöntemin katkıları neler?

2- Okuduğunu anlama becerisini geliştirmek için ne gibi materyaller kullanıyorsunuz? Kullandığınız materyaller ihtiyaçlarınızı karşılıyor mu? Hayır;
   - Ne tür öğretim materyallerine ihtiyaç olduğunu düşünüyorsunuz?
        i. Dijital multimedya materyaller (çoklu ortam materyalleri)- Ses, görsel ve metin destekli materyaller
   Evet;
   - Bu materyaller hangi yönleriyle ihtiyaçlarınızı karşılıyorlar? Kullandığınız materyalden bahseder misiniz?

3- Okuduğunu anlama becerisini geliştirmek için başka herhangi bir bilgisayar temelli teknoloji kullanıyor musunuz? (Masaüstü veya tablet uygulamaları, sesi metne çeviren veya metni seslendiren yazılımlar vs.)
   Evet ise;
   a. Kullandığınız teknolojiler hangileri?
   b. Bu teknolojileri tercih etme sebeplerinizden bahseder misiniz?
        i. Var olan materyallerin yetersiz olması
        ii. Okul içi ve okul dışında pratik yapma şansı
        iii. Öğrenmeyi pekiştirme
        iv. Kendi başına çalışabilme fırsatı
        v. Kendi öğrenmesi üzerinde kontrol sağlamasına yardımcı olma
   Hayır ise;
   c. Neden kullanmadınız? Sebeplerinizden bahseder misiniz?

        i. Var olan materyallerin ihtiyaca uygun olarak tasarlanmamış olması

       ii. Ücretli olmaları

4- Çocukların okuduklarını anlama becerilerini geliştirmek için dijital bir eğitim materyali tasarlayacağım. Bu materyali tasarlarken kelime bilgisi / kelime listesi stratejisinden faydalanacağım. Böyle bir materyal tasarlamak için ve size katkı sağlamak için ben nelere dikkat etmeliyim?

    a. Eğitsel içerik

        i. Metinlerin uzunluğu/ zorluk derecesi

       ii. Kullanılacak dil

      iii. Bilinmeyen kelimelerin öğretimi için

            1. Eş anlamlı zıt anlamlı görsel örnek cümle

    b. Görsel tasarım (ses, görsel, renkler)

    c. Materyal ile etkileşim

        i. Örnek ekran

       ii. Yardım ekranı

      iii. Sistemi kullanma süresi

      iv. İpuçları verme

SAF MADDE VE KARIŞIM

Çevremizdeki maddeleri saf maddeler ve karışımlar olarak da sınıflandırabiliriz. İçerisinde kendinden başka bir madde içermeyen maddelere saf madde denir. Örneğin, bir kâse toz şekerin içerisindeki bütün tanecikler şeker taneciği olduğu için şeker saf maddedir. Ayrıca, tuz, su, demir, bakır, altın, alüminyum ve gümüşü de saf maddelere örnek olarak verebiliriz. Saf maddelerin özellikleri maddenin her yerinde aynıdır. Saf madde ne kadar küçük parçalara ayrılırsa ayrılsın yine de kendi özelliğini korur. Örneğin, kaya tuzunu parçalara ayırdığımızda ayrılan her tuz parçası aynı özelliği gösterir.

İki ya da daha fazla saf maddenin kendi özelliklerini kaybetmeden bir araya gelmesiyle oluşan maddelere karışım denir. Tuzlu su, çay, limonata, çorbalar, salata, toprak ve deniz suyu birer karışım örneğidir. Karışımı oluşturan maddeler, karışım içerisinde kendi özelliklerini kaybetmezler. Örneğin, tuzlu su bir karışımdır. Bu karışımın içerisinde tuzu gözlerimizle göremeyiz. Ancak, suyun tadına baktığımızda suyun tuzlu olduğunu anlayabiliriz. Karışım içerisindeki maddeler hem özelliklerini kaybetmezler hem de her miktarda bir araya gelebilirler. Örneğin, salatanın içinde farklı miktarlarda domates, soğan, marul ve salatalık vardır. Salatayı yediğimizde içerisindeki soğan, domates, marul ve salatalığın tadını alabiliriz. Yani bu maddeler bir araya gelince özelliklerini kaybetmezler.

Karışımları ayırdığımızda karışan maddeleri, özelliklerini kaybetmeden tekrar elde edebiliriz. Karışımları ayırmak için eleme, süzme ve mıknatısla ayırma gibi yöntemler kullanılmaktadır. Farklı büyüklükteki katı maddelerden oluşan karışımları ayırmak için eleme yöntemi kullanılır. Örneğin, çakıl taşı ve kum karışımını elek kullanarak ayırabiliriz. Bu karışımı elediğimizde kum küçük taneli olduğu için eleğin gözeneklerinden geçer ve çakıl taşlarından ayrılmış olur. Katı ve sıvı maddelerden oluşan karışımları ayırmak için süzme yöntemi kullanılır. Örneğin, makarnayı haşladığımız zaman süzgeçten süzerek makarna ve suyu ayırmış oluruz. İçinde demir ve nikel gibi maddeler bulunan karışımları ayırmak için ise mıknatısla ayırma yöntemi kullanılır. Örneğin, demir tozu ve tuz karışımında mıknatısla demir tozlarını çekebiliriz.

BESİNLER VE ÖZELLİKLERİ

Canlıların, yaşamsal faaliyetlerini sürdürebilmeleri için yiyecek ve içeceklere yani besinlere ihtiyacı vardır. Besinlerin bazılarını hayvanlardan, bazılarını da bitkilerden elde ederiz. Tükettiğimiz besinlerde farklı besin içerikleri vardır. Başlıca besin içerikleri proteinler, karbonhidratlar ve yağlardır.

Günlük yaşamımızda koşarız, zıplarız, yürürüz, otururuz, kalkarız... Tüm bunları yapmak için enerjiye ihtiyaç duyarız. Karbonhidratlar, vücudumuzun ihtiyacı olan enerjiyi sağlar. Karbonhidratlar, mısır, buğday ve yulaf gibi tahıl ürünlerinde bulunur. Ayrıca, meyve ve sebzelerde, bal, reçel ve pekmez gibi ürünlerde bolca bulunur. Fazla tüketilen karbonhidratlar, vücutta yağa dönüşerek şişmanlamamıza neden olur.

Proteinler, vücudumuzun büyüyüp gelişmemizi sağlayan besin grubudur. Proteinler hem hayvansal hem de bitkisel besinlerde bulunur. Et, süt, tavuk ve balık başlıca hayvansal protein kaynaklarımızdandır. Kuru fasulye, mercimek, nohut, bulgur ve pirinç ise bitkisel protein kaynaklarımızdır. Fındık, fıstık, badem ceviz gibi kuruyemişler de zengin protein içeriğine sahiptir. Saçlarımızın ve tırnaklarımızın uzaması, kırılan kemiklerimizin onarılması proteinlerin sayesinde gerçekleşir.

Yağlar da karbonhidratlar gibi vücudumuzun enerji ihtiyacını karşılar. Uzun süre aç kaldığımızda karbonhidratlardaki enerji yetersiz kalır. Bu durumda enerji ihtiyacımızı yağlardan sağlarız. Yağlar bitkisel gıdalardan en çok zeytin, ayçiçeği, mısır, ceviz, fındık ve susamda bulunur. Tereyağı ise hayvansal yağlara örnektir. Karbonhidratlar gibi yağların da aşırı tüketimi olumsuz sonuçlara yol açabilir. Vücudumuz yağın fazlasını depolar. Depolanan yağlar da fazla kiloya neden olur.

H. Reading Comprehension Test

Lütfen aşağıdaki soruları dikkatlice oku ve cevapla.
Soru 1:
    I.   Saf maddeler ve özellikleri
    II.   Karışımlar ve özellikleri
    III.   Karışımları ayırma yöntemleri
    IV.   Maddelerin hal değişimi

Yukarıdakilerden hangileri metinde anlatılmaktadır?
    a. Yalnız I
    b. I ve II
    c. I, II ve III
    d. III ve IV

Soru 2: Aşağıdakilerden hangisi verilen metin için **en uygun** başlıktır?
    a. Maddenin özellikleri
    b. Saf maddeleri ayırma yöntemleri
    c. Saf maddeler ve karışımların özellikleri
    d. Karışımlar

Soru 3: Aşağıdakilerden hangisi verilen metine göre doğrudur?
    a. Eleme, saf maddeleri ayırmak için en çok kullanılan yöntemdir.
    b. Karışımları ayırmak için kullanılan birçok yöntem vardır.
    c. Saf maddeler parçalandıklarında özelliklerini kaybederler.
    d. Günlük yaşamımızda karışım görmemiz mümkün değildir.

Soru 4: Aşağıdakilerden hangisi bu metnin genel amacıdır?
    a. Saf maddeleri ayırma yöntemleri arasındaki farkları anlatmak
    b. Saf maddelere örnek vermek
    c. Karışımlara örnek vermek
    d. Saf maddeler ve karışımlar hakkında bilgi vermek

Soru 5: Metinde geçen "**saf madde**" kelimesi ne anlama gelmektedir?
    a. İçerisinde kendinden başka bir madde içermeyen maddelere verilen isimdir.
    b. Birden çok maddenin özelliklerini kaybetmeden bir araya gelmesidir.
    c. Birden çok maddenin farklı miktarlarda bir araya gelmesidir.
    d. Karışımları ayırmak için kullanılan bir yöntemdir.

Soru 6: Aşağıdakilerden hangisi saf maddenin özelliklerinden biridir?

    a. Birden çok maddenin bir araya gelmesiyle oluşur.

    b. Saf maddenin özelliği maddenin her yerinde aynıdır.

    c. Bir saf madde parçalara ayrılamaz.

    d. Saf maddeleri ayırmak için süzme yöntemi kullanılır.

Soru 7: Aşağıdakilerden hangisi saf maddelere örnektir?

    a. Toprak

    b. Çay

    c. Bakır

    d. Limonata

Soru 8: Metinde geçen "**karışım**" kelimesi ne anlama gelmektedir?

    a. Tek bir saf maddeden oluşan varlıklara verilen isimdir.

    b. Saf maddeleri ayırmak için kullanılan bir yöntemdir.

    c. Küçük parçalara ayrılınca özelliklerini kaybeden maddelere verilen isimdir

    d. Birden fazla farklı maddenin özelliklerini kaybetmeden bir araya gelmesidir.

Soru 9: Aşağıdakilerden hangisi karışımın özelliklerinden biri **değildir**?

    a. Birden çok saf maddenin bir araya gelmesiyle oluşur.

    b. Karışımlar kendini oluşturan maddelere ayrılamazlar.

    c. Karışımı oluşturan maddeler her miktarda bir araya gelebilirler.

    d. Karışımı oluşturan maddeler kendi özelliklerini kaybetmezler.

Soru 10: Aşağıdakilerden hangisi karışımlara örnektir?

    a. Altın

    b. Tuz

    c. Çorba

    d. Alüminyum

Soru 11: Aşağıda verilen karışımı ayırma yöntemlerinden hangisi doğrudur?

    a. Çakıl taşı ve kum karışımını ayırmak için süzme yöntemi kullanılır.

    b. Sıvı ve katı maddelerden oluşan karışımlar eleme yöntemi ile ayrılırlar.

    c. Tuz ve demir tozu karışımını ayırmak için mıknatısla ayırma yöntemi kullanılır.

    d. Sebze çorbası eleme yöntemi ile ayrılır.

Soru 12: Bir kapta bulunan tuz – demir tozu karışımına <u>mıknatısla ayırma yöntemini</u> uyguladığımızda kapta aşağıdakilerden hangisi kalır?

    a. Tuz ve demir tozu

    b. Tuz

    c. Demir tozu

    d. Hiçbir şey

Soru 13: <u>Farklı büyüklüklerdeki katı maddelerden oluşan bir karışımı</u> ayırmak için aşağıdaki yöntemlerden hangisi kullanılır?

    a. Saf madde

    b. Eleme

    c. Mıknatısla ayırma

    d. Buharlaştırma

Soru 14: Aşağıdaki ayırma yöntemlerinden hangisi <u>pirinç - su karışımını</u> ayırmak için kullanılır?

    a. Süzme

    b. Eleme

    c. Saf madde

    d. Mıknatısla ayırma

I. Vocabulary Test

Lütfen aşağıdaki soruları dikkatlice oku ve cevapla.

Soru 1: Aşağıdaki maddelerden "Saf madde" olanların altındaki kutuya "X" işareti koy.

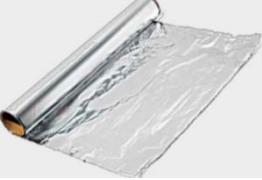|		
(Tuz) ☐	**(Gümüş)** ☐	**(Limonata)** ☐
(Altın) ☐	**(Ayran)** ☐	

Soru 2: Aşağıdaki soruyu oku. Cevabını kutucuğa yaz.

> İçerisinde kendisinden başka madde bulundurmayan maddelere ne isim verilir?
>
> [   ]

Soru 3: Aşağıdakilerden hangisi "saf madde" kelimesinin tanımıdır?

a. Birden çok maddenin bir araya gelmesiyle oluşan maddelere verilen isimdir.
b. Karışımları ayırmak için kullanılan bir yönteme verilen isimdir.
c. Tek bir maddeden oluşan maddelere verilen isimdir.
d. Maddenin sıvı haline verilen isimdir.

Soru 4: Aşağıdaki maddelerden "<u>Karışım</u>" olanların altındaki kutuya "X" işareti koy.

(Çorba)	(Su)	(Çay)
(Limonata)	(Alüminyum)	

Soru 5: Aşağıdaki soruyu oku. Cevabını kutucuğa yaz.

Birden çok maddenin özelliklerini kaybetmeden bir araya gelmesiyle oluşan maddelere ne isim verilir?

Soru 6: Aşağıdakilerden hangisi "<u>karışım</u>" kelimesinin tanımıdır?

a. Birden çok maddenin bir araya gelmesiyle oluşan maddelere verilen isimdir.
b. Tek bir maddeden oluşan maddelere verilen isimdir.
c. Maddeleri ayırmak için kullanılan yönteme verilen isimdir.
d. Küçük parçalara ayrılamayan maddelere verilen isimdir.

Soru 7: Aşağıdaki karışımları incele. "<u>Eleme</u>" ile ayrılacak olan karışımların altındaki kutuya "X" işareti koy.

(Çakıl - Kum)	(Taş - Toprak)	(Kömür – Kömür Tozu)
(Makarna - Su)	(Çay Yaprakları - Çay)	

Soru 8: Aşağıdaki soruyu oku. Cevabını kutucuğa yaz.

> **Farklı büyüklükteki katı maddelerden oluşan karışımları ayırmak için**
>
> **kullanılan yöntemin adı nedir?**

Soru 9: Aşağıdakilerden hangisi "<u>Eleme</u>" kelimesinin tanımıdır?

a. Birden çok maddenin bir araya gelmesiyle oluşan maddelere verilen isimdir.
b. Farklı büyüklükteki katı maddelerden oluşan karışımları ayırmak için kullanılan bir yöntemdir.
c. Tek bir maddeden oluşan maddelere verilen isimdir.
d. Küçük parçalara ayrılabilen maddelere verilen isimdir.

Soru 10: Aşağıdaki karışımları incele. "<u>Süzme</u>" ile ayrılacak olan karışımların altındaki kutuya " X " işareti koy.

(Çorba) □	(Su) □	(Makarna - Su) □
(Çakıl Taşı - Su) □	(Limonata) □	

Soru 11: Aşağıdaki soruyu oku. Cevabını kutucuğa yaz.

> Katı ve sıvı maddelerden oluşan karışımları ayırmak için kullanılan yöntemin adı nedir?
>
> □

Soru 12: Aşağıdakilerden hangisi "<u>süzme</u>" kelimesinin tanımıdır? Seç

   a. Birden çok maddenin bir araya gelmesiyle oluşan karışıma verilen isimdir.
   b. Saf maddeleri parçalamak için kullanılan bir yöntemdir.
   c. Katı ve sıvı maddelerden oluşan karışımları ayırmak için kullanılan yöntemdir.
   d. Tek bir maddeden oluşan maddelere verilen isimdir.

Soru 13: Aşağıda "Saf madde" ve "Karışım" örnekleri verilmiştir. Bu maddeleri ait oldukları kutulara yaz.

Altın	Bakır	Limonata
Sebze çorbası	Tuzlu su	Tuz

Saf	Karışımlar

Soru 14: Aşağıda "Eleme" yöntemi ve "Süzme" yöntemi ile ayrılacak karışımlara örnekler verilmiştir. Karışımları inceleyerek ait oldukları kutulara yaz.

Çakıl Taşı- Kum	Kömür-Kömür Tozu	Çakıl Taşı- su
Pirinç -Su	Taş - Toprak	Makarna -Su

Eleme	Süzme

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J. The Evaluation Form for Classroom Teachers / Academics

Sayın Hocam,

Doktora tezimde öğrenme güçlüğü olan öğrencilerin bilgilendirici metinlerdeki anlama düzeylerini kelime öğretimi yoluyla desteklemeyi amaçlayan bir dijital materyalin tasarım sürecini çalışıyorum. Materyalimi hazırlayabilmem için bilgilendirici metinler seçmem ve düzenlemem gerekiyor. Sizden ricam ekte bulunan metinleri 4. Sınıf düzeyine uygunluğu, metnin içeriğinin doğruluğu ve metnin içeriğinin yoğunluğu açısından değerlendirmeniz. Size gönderdiğim metinleri Millî Eğitim Bakanlığının şu anda kullandığı fen bilgisi kitaplarını kullanarak düzenledim. Metinler içerik anlamında uygun bulunduğu takdirde özel eğitim ve Türkçe alanında çalışan akademisyenlerden tarafından biçim, dil ve uygunluk anlamında tekrar değerlendirilecektir. Metinlerimi bahsi geçen kriterlere göre değerlendirebilmeniz için aşağıdaki tabloyu doldurmanızı rica edeceğim. Her metin için uygunluk düzeyini 1-hiç uygun değil ve 5- çok uygun arasında değerlendirebilirsiniz. Hocam ayrıca bu metinler ve kelimeler materyal içerisinde görseller ve videolarla desteklenerek anlatılacaktır. Yine metinlerin biçim ve formatı öğrenme güçlüğü olan öğrenciler düşünülerek tasarlanacaktır.

Hocam tezimde sizlerden destek aldığımı belirtebilmem için aşağıdaki bilgileri doldurmanızı da rica edeceğim. Verdiğiniz bilgiler başkalarıyla hiçbir şekilde paylaşılmayacaktır. Bilgileriniz sadece tezim kapsamında kullanılacaktır.

Mezun olduğunuz üniversite / bölüm: ……………

Mezuniyet yılınız: …………………………

Fen bilgisi öğretmeni olarak kaç yıldır görev yapıyorsunuz: ………………

Metin numarası	Metnin 4. Sınıf düzeyine uygunluğu (1-hiç uygun değil; 5-çok uygun)	Metnin içeriğinin doğruluğu (1-hiç uygun değil; 5-çok uygun)	Metnin içeriğinin yoğunluğu (1-hiç uygun değil; 5-çok uygun)
Metin 1			
Metin 2			
Metin 3			
Metin 4			

K. Text Evaluation Forms for Turkish Teachers

Sayın Hocam,

Ekte sunulan metinler "Öğrenme güçlüğü olan öğrencilerin bilgilendirici metinlerdeki okuduğunu anlamalarına kelime öğretimi yoluyla katkıda bulunmayı sağlayan bir dijital materyalin tasarımı ve geliştirilmesi" isimli Prof. Dr. Ömer DELİALİOĞLU danışmanlığında yaptığım doktora tezimde öğrencilerin okuduğunu anlama düzeylerini belirlemek amacıyla hazırlanacak olan 4. sınıf okuduğunu anlama başarı testinde kullanılmak üzere seçilmiştir. Seçilen metinlerin okunabilirlik formülü ile (Ateşman 1997) 4. sınıf düzeyine uygunluğu belirlenmiştir. Sizden;

a) Metinleri kalite bakımından; organizasyonu, kelime seçimi, cümle yapısı, dilbilgisi kuralları, metnin tutarlılığı ve bağdaşıklığı olmak üzere 6 ölçüte göre bütüncül olarak (holistic) değerlendirmenizi ve

b) Metnin içeriğinin 4. sınıf düzeyine uygunluğunun; üslup, metindeki fikirler, kavramsal yoğunluk olmak üzere 3 ölçüte göre değerlendirmenizi rica ederim. 1 uygun değil -5 ise çok uygunu ifade etmektedir.

Saygılarımla
Arş. Gör. Sibel DOĞAN
Orta Doğu Teknik Üniversitesi (ODTÜ),
Bilgisayar ve Öğretim Teknolojileri eğitimi Bölümü (BÖTE)

Mezun olduğunuz üniversite / bölüm: ……………

Mezuniyet yılınız: ………………………

Fen bilgisi öğretmeni olarak kaç yıldır görev yapıyorsunuz: ………………..

Metnin kalite bakımından ☐ Organizasyonu ☐ Kelime seçimi ☐ Cümle yapısı ☐ Dilbilgisi kuralları ☐ Metnin tutarlılığı ve bağdaşıklığı						Metnin içerik bakımından **4. sınıfa uygunluğu** ☐ Üslup ☐ Metindeki fikirler ☐ Kavramsal yoğunluk				
Metin – 1	1	2	3	4	5	1	2	3	4	5
Metin – 2	1	2	3	4	5	1	2	3	4	5
Metin – 3	1	2	3	4	5	1	2	3	4	5
Metin – 4	1	2	3	4	5	1	2	3	4	5

L. Interviews with LD students

1- Materyali kullanırken 4 tane kelime öğrendin. Bu kelimeleri hatırlıyor musun?

    a. Hayır

    b. Evet ise;

    Bu kelimeler hangisiydi?

2- Bir tane metin okudun. Bu kelimeler okuduğun metnin içinde var mıydı? Hatırlıyor musun?

    a. Hayır

    b. Evet ise;

        Okuduğun metnin içinde bu kelimelerden hangileri vardı?

3- Öğrendiğin kelimeler, metni okurken işine yaradı mı?

    a. Hayır

    b. Evet ise;

        Kelimeler işine nasıl yaradı?

          ● Okumamı kolaylaştırdı

          ● Metini anlamamı kolaylaştırdı

4- Pratik alanları işine yaradı mı? Nasıl?

5- Kelimeler farklı renklerde yazılmıştı. Dikkatini çekti mi?

    a. Hayır

    b. Evet ise; okurken işine yaradı mı?

6- Sesler ve videolar işine yaradı mı? Evet ise nasıl?

    a. Sesleri dinlediyse Neden?

    b. Sesleri dinlemediyse neden?

7- Kullandığın materyalde beğenmediğin ya da zorlandığın bir şey var mıydı?

    a. Hayır

    b. Evet ise;

    Neden?

8- Bu materyali daha sonra da kullanmak ister misin? Neden?

M. Observation Form Used in Pretest Session

<div align="center">

KELİME TESTİ

</div>

Teste Başlama Saati:	
Testi Bitirme Saati:	

	Soruyu Okudu Cevapladı	**Soruyu Okudu Cevaplamadı**	**Soruyu okumadı. Araştırmacının uyarısıyla okuyup cevapladı**
Soru 1			
Soru 2			
Soru 3			
Soru 4			
Soru 5			
Soru 6			
Soru 7			
Soru 8			
Soru 9			
Soru 10			

<div align="center">

OKUDUĞUNU ANLAMA METNİ VE SORULARI

</div>

Metni okumaya başlama saati:		Okuduğunu Anlama Sorularına Başlama Saati:	
Metni okumayı bitirme saati:		Okuduğunu Anlama Sorularını Bitirme Saati:	

	Soruyu Okudu Cevapladı	**Soruyu Okudu Cevaplamadı**	**Soruyu okumadı. Öğretmenin uyarısıyla okuyup cevapladı**
Soru 1			
Soru 2			
Soru 3			
Soru 4			
Soru 5			
Soru 6			
Soru 7			
Soru 8			
Soru 9			
Soru 10			
Soru 11			
Soru 12			
Soru 13			
Soru 14			

N. Observation Form Used in Posttest Session

KELİME ÖĞRETİMİ ve KELİME TESTİ

Öğretime Başlama Saati		Kelime Testine Başlama Saati:	
Öğretimi Bitirme Saati:		Kelime Testini Bitirme Saati:	

zcbvsfbsfxn

OKUDUĞUNU ANLAMA SORULARI

Metni okumaya başlama saati:		Okuduğunu Anlama Sorularına Başlama Saati:	
Metni okumayı bitirme saati:		Okuduğunu Anlama Sorularını Bitirme Saati:	

Öğrenci karakter seçti mi ?	A) Evet B) Hayır
Öğrenci karakteri aksesuar takarak özelleştirdi mi?	A) Evet B) Hayır
Hangi yazı tipini seçti?	A)1 B)2 C)3 D)4 E) Hiçbir şey
Hangi yazı boyutunu seçti?	A)1 B)2 C)3
Hangi arka plan rengini seçti?	A)1 B)2 C)3 D)4 E) 5
Öğretimde bütün örneklerin bir arada sunulduğu alanları inceledi.	A) Evet B) Hayır
Kelime testi sonucunu inceledi.	A) Evet B) Hayır
Kelime testinde verdiği cevapları geri dönüp inceledi.	A) Evet B) Hayır
Metni okumadan önce öğrendiği kelimeleri tekrar etti.	A) Evet B) Hayır
Okuma metninin yazı boyutunu kendine göre ayarladı mı?	A) Evet B) Hayır
Okuduğunu anlama sorularına başlamadan önce metne geri dönüp okudu mu?	A) Evet B) Hayır
Okuduğunu anlama testi sonucunu inceledi.	A) Evet B) Hayır
Okuduğunu anlama testinde verdiği cevapları geri dönüp inceledi.	A) Evet B) Hayır

	1 (Hiç)	2	3	4	5	6	7 (Hep)
Kelimeleri öğrenirken tanımları okudu.							
Kelimeleri öğrenirken, görselleri inceledi.							
Kelimeleri öğrenirken, sesleri dinledi.							
Kelimeleri öğrenirken, videoları izledi.							
Kelimeleri öğrenirken, kelimelerdeki vurgular dikkatini çekti.							
Bağımsız çalışma alanlarında konuya dön butonunu kullandı.							
Bağımsız çalışma alanlarında bulunan sürükle bırak ve seç gibi etkileşimleri yapabildi.							
Kelimeleri öğrenirken, görseller dikkatini çekti.							
Kelimeleri öğrenirken, sesler dikkatini çekti.							
Kelimeleri öğrenirken, videolar dikkatini çekti.							

O. Demographic information survey

Öğrenme Güçlüğü Yaşayan Öğrenciler için Kişisel Bilgiler Anketi

1) Öğrencinin Kişisel Bilgileri

   - Cinsiyeti:

   - Yaşı:

   - Sınıfı:

2) Öğrenim gördüğü okul:

   A) Devlet Okulu   B) Özel Okul

3) Öğrenme güçlüğü tanısı var mı?

   A) Evet   B) Hayır

   B) Öğrenme güçlüğünün yanı sıra başka bir engeli var mı?

   A) Evet   B) Hayır

   EVET ise;

   a. Diğer engel türü :

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Doğan, Sibel
e-mail: sidogan@metu.edu.tr

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Computer Education and Instructional Technology	2015
BS	METU Computer Education and Instructional Technology	2012
High School	Avcılar Vocational and Technical Anatolian High, İstanbul	2004

WORK EXPERIENCE

Year	Place	Enrollment
2020 - Present	METU Registrar's Office	Instructor
2012 - 2020	METU Computer Education and Instructional Technology	Research Assistant

FOREIGN LANGUAGES

Advanced English, Fluent

PUBLICATIONS

International Conference Papers

1. Donmez M., Dogan S. and Baran E. "Sinyal İlkesinin Öğrenme Üzerindeki Etkileri: Bir Göz Hareketleri İzleme Çalışması", 12th International Computer & Instructional Technologies Symposium, (2018)

2. Kadirhan, Z., Alkış, Y., Çelik, B., Doğan, S., & Yıldırım, İ. S. Investigating the Relationship between Nomophobia and Self-esteem among University Students. 12th International Computer & Instructional Technologies Symposium, (2018)

3. Doğan, S., & Delialioğlu, Ö. Technology usage in specific learning disabilities: A Systematic literature review. 12th International Computer & Instructional Technologies Symposium, (2018)

4. Aslan O., Dogan S., Donmez M. and Yildirim S. "Öğretim Teknolojileri Alanında Temel Araştırma Alanları ve Araştırma Yöntemleri Problemleri İçin Bir Çözüm

Önerisi: Bilişsel Etnografya", 12th International Computer & Instructional Technologies Symposium, (2018)

5. Doğan, S., & Çağıltay, K. Examining the Instructional Technologies and Strategies Used in the Village Institutes and Their Applications into Today'xxs Educational Settings. International Computer & Instructional Technologies Symposium, (2017)

6. Dogan S., Aslan O., Donmez M. and Yildirim S. "Sözde Kod Oluştururken Öğrencilerin Zihinsel Süreçlerindeki Farklılıklar: Bilişsel Etnografi Çalışması", 11th International Computer & Instructional Technologies Symposium, (2017)

7. Caner, S., Dogan, S., & Çelik, B. "Keywording" in Facebook Groups: A Case Study on Grouping Posts in an Informal Online Learning Community. EDULEARN17, (2017)

8. Doğan, S., Caner, S., & İşgör Şimşek, E. A Case Study of Informal Online Community for Graduate Students: A Community of Practice Design. International Instructional Technologies & Teacher Education Symposium (ITTES), (2016)

9. Doğan, S. Teknoloji Entegrasyonunun Önündeki engeller: Bir Fakülte Teknoloji Mentörlük Projesi Örneklemi. International Instructional Technologies & Teacher Education Symposium (ITTES), (2016)

10. Doğan, S. Sistematik Literatür Taraması: Öğrenme Güçlüklerinde Teknoloji Kullanımı. International Instructional Technologies & Teacher Education Symposium (ITTES), (2016)

11. Dogan S., Donmez M., Islim O. F. and Sevim N. "BÖTE Öğrencilerinin Bölümlerine Yönelik Algısı Ankara Örneği", Tenth International Computer & Instructional Technologies Symposium, (2016)

12. Kaplan, G., & Doğan, S. Accelerating Learning of Special Education Studentswith Intellectual Disability via Technology Enhanced Extracurriculum. Association for Educational Communications & Technology, (2015)

13. Doğan, S., & Çağıltay, K. Zihinsel Engelli Öğrenciler ile Bilişim Teknolojileri Etkinlikleri: Topluma Hizmet Dersi Örnek Uygulaması İncelemesi. International Computer & Instructional Technologies Symposium, (2014).

14. Kaplan Akıllı, G., & Doğan, S. Web 2.0 at Work: Utilization of a Web 2.0 tool in a pre-service teacher education course. International Instructional Technologies & Teacher Education Symposium (ITTES), (2013)

National Journal Papers

1. Donmez M., Dogan S. and Baran E. "How Signaling Principle Affects Learning: An Eye Tracking Study", Mersin University Journal of the Faculty of Education, (2018)

2. Dogan S., Aslan O., Donmez M. and Yildirim S. "Investigation of Students' Cognitive Processes in Computer Programming: A Cognitive Ethnography Study", Turkish Online Journal of Qualitative Inquiry, (2019)

3. Aslan O., Donmez M., Dogan S. and Yildirim S. "Bilişsel Etnografya: Kuramsal Çerçeveler, Yöntemler ve Süreçler", Eğitim Teknolojisi Kuram ve Uygulama, (2019)

4. Dogan, S., & Delialioğlu, Ö. "A systematic Review on the Use of Technology in Learning Disabilities". Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 21(3), 611-638 (2020).