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Supporting learning difficulties with e-book based on context-based teaching strategy from social perspective: design and experience

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Abstract
Although the positive effects of the use of technology for students with learning disabilities (LD) have been reported, there is a lack of both theory and practice in terms of integrating technology with the appropriate strategy in accordance with the student, content and purpose. Both teaching materials developed with qualified strategies and the active involvement of the target audience in the process are a need to design effective and sustainable learning materials and processes for LD. This study involved both the production of a material with the common views of stakeholders related to LD (individuals diagnosed with LD, special education teachers, academics working on LD) and the examination of the effectiveness of this material. The focus of the study is primarily on the fact that human being is a social being and learning, language and reading are social phenomena. In this context, within the framework of social constructivist perspective, an e-book design based on context based teaching (CBT) strategy and its effectiveness on reading performance were analysed. The study involved a two-stage process. In the first phase, design-based research was conducted and a CBT-supported e-book (DIJIKIT) was developed. In the second stage, DIJIKIT and an e-book were compared in an adapted alternating implementation design. The participants of the study in the CBT process consisted of researchers, three special education teachers, academicians and two primary school students diagnosed with learning disabilities. In each cycle of the DBR, the participants provided feedback on the material. Semi-structured interviews, focus group discussions, video recordings and a researcher's diary were used as data collection tools in the DBR. As a result of the DBR, DIJIKIT design and content features were determined. In the experimental process, DIJIKIT was used by three primary school students diagnosed with learning disabilities. In the experimental process, efficacy (the informal reading invetory), reliability (treatment integrity, interobserver agreement) and social validity (social validity forms) data were collected. The reading comprehension performances and reading levels of all three students increased. Social validity data supported the experimental process data and clearly demonstrated the need for effective instructional technologies for both parents and teachers. The study

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offers practical implications and recommendations for future researchers in terms of exemplary design features and greater visibility of the relationship between instructional technologies and special education.

Keywords Learning disability · Context based teaching · Reading · Design based research · E-book

1 Introduction

It is possible for a child who has just started school to acquire the basic language skills that it will benefit from throughout its life through an effective, planned and consistent first literacy teaching process. In order for a student to acquire reading skills, it should be able to understand written symbols, the relationships of these symbols in words, phrases and sentences, make meaning from written information, store this meaning and recall it when needed (Gillon, 2004). If a student has problems in acquiring reading skills at the beginning of academic life, this problem will affect its entire academic and social life and pave the way for bigger problems. While a student with better reading skills will read more and reach more meaning, a student with less good or poor reading skills will read slowly, will not enjoy reading, and the student's academic and social processes will be negatively affected (Stanovich, 1986). Reading, a literacy skill, is an integral part of the right to education (UNESCO, 2019). The individual has to be a good literate in order to keep up with the age. Reading, which has such a critical place, has become a common endeavour of educational policies (Leu & Maykel, 2016). Reading is a complex action that occurs with continuous interaction between text and human, involves continuity and affects cognition. As the individual reads, he/she creates meaning, and as it creates meaning, it restructures its cognition (Jackson, 2016). Reading, which has social, linguistic and psychological dimensions (Bin-Tahir et al., 2018; Cervetti et al., 2009), involves the analysis, coordination, questioning and interpretation of different sources (Scanlon, 2010). The reading process explains the creation of meaning between the reader and the author, which involves complex mental skills depending on the reader's prior knowledge (Baştuğ & Akyol, 2012).

In the reading process, which is still being discovered as a very complex structure, words, vocabulary are deciphered, reading comprehension is associated with concepts such as oral speech, reading motivation, and meaning is continuously extracted from written texts (McShane, 2005). Reading, which is considered as a critical skill for academic success (Snow, 2002), reaches its ultimate goal with reading comprehension. Understanding the text we read includes skills such as discovering valuable information and relationships in the text, evaluating, criticising and questioning the information in accordance with the purpose (Rojas Rojas et al., 2019). While reading, we search for and find meaning with an active mind, think about meaning, search for reasons, draw conclusions and evaluate (Balcı, 2017; Marton & Saljö, 1976).

While reading, mental representations about semantic relations and information in the text are formed with the coordination of decoding and vocabulary (Kendeou et al., 2014). Unfortunately, a skill that is so complex and directly affects academic and social life cannot be performed at the expected level by some individuals. Generally, there are individuals who have intense, relatively permanent (requiring support) difficulties in reading and need special education support with the diagnosis of "Learning Disability". Although this concept was tried to be explained in terms such as neurological damage, minimal brain damage, Strauss Syndrome or aphasia until the 1960s, it is an area that cannot be fully explained even now and is an area of intense debate (Albeyoğlu, 2021). These students do not have any mental retardation, auditory or visual problems, but they have problems in some academic and social interactions, especially in reading (Pierangelo & Giuliani, 2006). There is no limited, precise and common list of characteristics of students with LD. In fact, each student with LD may experience difficulties in different areas and to different degrees (Hale et al., 2010). These learners are also labelled as "slow learners" because they cannot have reading comprehension skills at a speed and depth close to their peers due to the problems they experience in reading (Sleeter, 2010). With the onset of literacy-related efforts, this difficulty is evident in children (Thomson & McKenzie, 2005). Even if it is assumed that not every child can be recognised and diagnosed, LD has a very high rate in special education categories (Kranzler et al., 2019).

Although students in the LD group have normal or above normal intelligence levels, adequate educational opportunities and motivation to learn, they have difficulties in areas such as reading, writing or mathematics (Kranzler et al., 2019). Some students with LD may confuse the positions of letters while reading, see words as if they are intertwined, or read as if there are no spaces between them (Balcı, 2017). Emotional and behavioural problems such as decreased self-esteem, decreased psychological well-being, anxiety and stress symptoms, avoidance of the school environment, and low academic performance may occur in individuals diagnosed with LD due to problems in reading (Eissa, 2010). Although the organic causes of LD have not been fully elucidated, it is also thought that this disorder is caused by difficulties in phonological awareness, that is, the ability to distinguish the sound corresponding to the letter that forms words (Pierangelo & Giuliani, 2006). Some of the theories that are interested in why LD occurs claim that LD occurs due to inadequate or incorrect decoding in written text (Wood et al., 2018). It is also stated that students with LD approach reading more superficially, use fewer strategies for comprehension, make more use of prior knowledge, and have less vocabulary (Orosco, 2014). However, regardless of the reason, it is important and necessary to design effective and continuous interventions.If adequate and effective support is not provided, students with LD will face growing academic deficiencies that are difficult to compensate for. It is a responsibility for educators to create the best, most appropriate learning process for "every" student and to endeavour to ensure that "every" student has access to these processes. And in the search for solutions within this responsibility, it is very important to create innovative, effective, explainable interventions and for the sustainability of the interventions created.

1.1 Context based teaching

In the social constructivist approach, language has a sociocultural structure and cannot be considered separately from the individual, society and interaction. Various cognitive skills (working memory, vocabulary, grammar, inferencing, word analysis, fluency, etc.) have direct and indirect effects on individuals' reading and comprehension (Kim, 2017; Lervag et al., 2018; Tighe & Schatschneider, 2016). In particular, it is seen that verbal language skills such as listening and word comprehension have significant effects on individuals' reading comprehension and vocabulary recognition, and thus on the development of individuals' reading (Dickinson et al., 2003; Nation & Snowling, 2004; Snow, 2020). Accordingly, it is obvious that individuals with low oral language skills are disadvantaged in terms of learning vocabulary through reading (Hill et al., 2017).

The ability of individuals to interact socially with others has an important place in the development of language skills. Similarly, the language skills of individuals have an important role in the development of their social skills (Riad et al., 2023; Snow, 2020). Supporting this view, Sparapani et al. (2018) stated that there is a reciprocal relationship between individuals' social skills, vocabulary knowledge and reading comprehension and that they contribute to each other's development. Individuals put their social-emotional skills to work in this process. This becomes an element that triggers comprehension. Yu et al. (2023) revealed that there is a significant relationship between individuals' social-emotional skills and reading skills, especially reading comprehension. With the activation of social-emotional skills, individuals can comprehend the feelings and thoughts of others while reading, thus enabling a social understanding (Kozak & Recchia, 2018).

Language skills, which are the most effective element in individuals' comprehension of what they read, are also effective on individuals' academic achievement (Ramsook et al., 2019; Riad et al., 2023; Snow, 2020); both language skills and social skills of individuals have a supportive role on their self-regulation (Ramsook et al., 2019). For this reason, it is important to provide social contact for individuals with weak related skills, especially for individuals in need of special education who are clearly weak in these skills. In fact, it is seen that their language development is significantly positively affected by the establishment of social contact (Hofmann & Müller, 2021). In addition, it has been stated that social-emotional readiness is as important as literacy skills for individuals in need of special education and that supporting them in this context will have positive effects on their academic success (Pentimonti et al., 2016).

Language is a prerequisite for a society, which is a social formation, to harbour a continuous and healthy communication. At this point, "context-based teaching (CBT)", which is one of the focal points of the project, is an approach that has a social constructivist identity and focuses on the consistency of daily life and teaching content. It enables students to find answers about how and why they will use newly learnt knowledge and skills (Şensoy & Gökçe, 2017) and takes into account constructivist learning theories and conceptual change frameworks (Parchmann et al., 2015). Information and communication technology (ICT) is defined as a curriculum design in which instructional content is presented to students in a variety of contexts

(Rose, 2012). ICT-based learning process is an innovation approach that is embedded in realistic environments and supports the application of procedural knowledge (Williams, 2008). By establishing a relationship with the contexts in daily life, the learners' learning is facilitated (Gilbert et al., 2011), their active participation in the lesson is ensured (Fensham, 2009) and their conceptual understanding is supported (Gilbert et al., 2011). The emphasis of ICT is to make students real-life problem solvers by creating student-centred learning situations that reflect real-life environments (Fechner, 2009). It assumes that learning will take place more easily, meaningfully and permanently in natural environments and suggests that learning activities should be carried out through an object or phenomenon from daily life when necessary (Bülbül et al., 2013). During this teaching, some possible problems such as information overload, failure to establish a connection between information, and failure to establish a relationship between information can be solved (Özay & Çam, 2011). Authentic and in-depth learning is possible with research-based projects such as ICT where real life experiences are combined with real life experiences and data are collected and analysed (Vonderwell et al., 2007).

Effective learning can take place if students can relate a concept and its applications to the real world, including their own culture, family or friends (Yang et al., 2005). Thus, students can associate symbolic learning content with real-world references using contexts (Westera, 2011). ICT encourages students to take responsibility for their learning and to relate knowledge and its application to various contexts of their lives (Satriani et al., 2012). In addition, ICT supports and motivates students' active participation in the process of making connections between their real lives (Coştu, 2009). Since this approach can be easily adapted to digital environments, it has been observed that e-learning environments are designed based on this approach and positively affect the learning process (Chen et al., 2018; Kwon et al., 2016). According to this approach, the learning process starts with a context from daily life. This is followed by the stage of arousing curiosity and planning in which an interesting story is presented. Activities related to the story are carried out. It is also possible to expand the subject content by giving direction to these activities. In the last stage, activities and story content are associated with the concepts to be taught. Students in the context are encouraged to integrate the necessary knowledge and skills that meaningfully benefit the student's transfer learning (Clark-Foos et al., 2009). It is claimed that learning should take place in a specific context, not out of context (Kindley, 2002). This experience can help them process what they have learnt (Chen et al., 2018). In this way, they will better understand how to apply their knowledge and skills in one scenario to other scenarios (Cormier & Hagman, 2014; McKeough et al., 2013). With ICT, it has been observed that students can take an active role in authentic contexts to improve their language skills by interacting with their peers (Di Blas & Paolini, 2014). In the theoretical basis of the project proposal, the importance of the social constructivist approach in general and the importance of context for reading in particular was focussed. While it is necessary to find appropriate strategies and methods for the difficulties faced by students with LD, it is also important to know the theoretical background of this obstacle (Khasawneh & Alkhawaldeh, 2020). Students with LD can reach the expected level of reading skills with productive contexts (diverse, relatable, multiple perspectives) (Antonacci & O'Callaghan,

2011; Nagy, 2005; Rasinski, 2012). Because context determines the meaning of the word and the semantic function of the sentence (Onan, 2012). Working on context requires both activating prior knowledge and doing more mental processing on new information. However, these students lack strategies that they can use while controlling, monitoring and recognising their own reading processes (Roberts et al., 2008). It is suggested that students should be exposed to the processes within the scope of ICT in order to overcome the obstacles experienced in reading and to become a good reader and meaning producer (Blachowicz & Fisher, 2011). While there are no studies that have examined ICT and learning disabilities with interventions integrating context-based strategies, we believe that social constructivism in general and reading in context more specifically are important for LD.

CBT helps learners learn by associating the content they learn with a meaningful context (Overton, 2007). For this reason, CBT is considered as an important approach for learners to solve the problems they face in their learning process (Sevian et al., 2018b) and to cope with difficulties (Gilbert et al., 2011). Learners are provided with contextual information at the beginning and during the learning process (Xun et al., 2017). The learner who experiences the context during the learning process performs various mental modeling (Xun et al., 2017) and is enabled to create coherent mental maps (Gilbert et al., 2011) and contributes to the transfer of this learning to new learning (Gilbert et al., 2011; Podschuweit & Bernholt, 2018; Sevian et al., 2018b; Tessmer & Richey, 1997). As a result, meaningful learning is encouraged (Tutal, 2023). In this direction, it is aimed to integrate CBT with instructional designs and to contribute various contextual elements to students' learning (Tessmer & Richey, 1997). There are also various studies in which various teaching materials based on CBT were designed and tested (Atmazaki, 2018).

CBT, which has been examined in many different courses and subject areas (Dori et al., 2018; Karasubaşı & Seyhan, 2023; Sevian et al., 2018a), is especially tested on reading and comprehension processes since context has an important effect on reading comprehension. Because it is stated that the use of context as a skill is related to reading comprehension (Singer & Crouse, 1981). Ensuring that learners' metacognitive skills are utilized in their learning processes is at the forefront (Dori et al., 2018). Studies show that CBT provides a significant increase in students' reading comprehension compared to other approaches (Indrayadi et al., 2020). Because it has been determined that the presence of context has a significant effect on students' reading comprehension (Castillo, 2008), facilitates their reading comprehension processes (Castillo, 2008) and improves their related skills (Dori et al., 2018; Overton, 2007; Utami et al., 2023). In this process, students perceive the context and the implicit clues presented to them and mentally direct the phenomenon (Rouet et al., 2017). In addition to all these, CBT has a positive effect on students' interest in reading (Atmazaki, 2018; Nursahak & Atmazaki, 2018; Ültay & Çalık, 2012), motivation (Overton, 2007; Tutal, 2023; Ültay & Çalık, 2012) and attitude (Tutal, 2023).

When considering reading comprehension studies in the context of CBT, it is seen that vocabulary learning also has an important place. Especially students who have difficulty in this regard stand out. Students who are inadequate in reading comprehension are largely unsuccessful in vocabulary knowledge and have difficulty in making sense of new words they encounter (Cain et al., 2004). In such cases,

presenting different contexts to beginner students allows them to reveal basic meanings and contributes to their vocabulary learning (Bolger et al., 2008; Tunmer & Chapman, 2004). In this direction, many studies show that variable contexts contribute to vocabulary learning and thus to students' reading performance (Joseph & Nation, 2018; Mol & Bus, 2011; Pagan & Nation, 2019).

In order to understand what is read, language acquisition must first be achieved. Understanding the language in its own context is the basic element. For this reason, it is a challenge that needs to be overcome for individuals with various learning difficulties (Collentine & Freed, 2004). One of the groups of students who have difficulties in reading comprehension is undoubtedly students with LD. One of the main reasons for this is that even if they have learned the words, they have difficulties in using the context effectively on their own (Stanovich, 1982). However, students with LD benefit from context in order to cope with their reading comprehension difficulties (Nation & Snowling, 1998), correct their possible errors (Pflaum & Pascarella, 1980) and improve their reading (Woods et al., 2005). If they are enabled to comprehend and use contexts, they will be able to move out of traditional learning environments and remove barriers to their academic progress (Mendez et al., 2008; Riddle, 2016), support their educational processes (Kang, 2017), and pave the way for them to be included in learning communities and take on participatory roles (Mendes et al., 2008). In this context, contextualizations to be employed in learning processes for students with LD will also make important contributions to teachers in order to understand what their difficulties are and what possible opportunities they may have (Turnbull, 2009; Woods et al., 2005). When the literature is examined, it is stated that the use of context in reading comprehension of students with LD based on CBT positively affects their reading performances, contributes to the understanding of these students' behaviors and paves the way for appropriate educational planning (Bulgren & Carta, 1992; Pflaum & Pascarella, 1980; Shogren et al., 2014; Woods et al., 2005). In addition to all these, Dudley-Marling (2004) stated that contexts in line with human relations and activities for students with LD can also contribute to their social development.

1.2 Supporting LD with e-book as instructional technology

It is the responsibility of educators to identify the barriers that students with LD experience in their learning processes and to produce appropriate solutions. By fulfilling these responsibilities, more effective, efficient and comfortable reading experiences can be provided for students with LD. At this point, it is important to integrate the right technology into learning processes within the right approaches by taking advantage of the opportunities and advantages offered by instructional technologies. With the introduction of computers into schools and homes, new opportunities have arisen for educators to improve their learning skills in different subject areas (Yelland et al., 2006). With regard to children with special needs, it has been reported that ICT can provide exciting and interesting experiences (Segers et al., 2006), and when programmed to reflect children's experiences and language, great improvements in literacy skills are observed (Segers & Verhoeven, 2005). However,

it is not possible for e-books to meet the needs of learners and improve their reading skills only by transferring printed content to digital media. At this point, it is important to design e-books by taking into consideration effective learning-teaching approaches and effective instructional design models. With the increase in research findings that different combinations of e-books such as interactive content and well-coordinated design features improve language and literacy skills, attempts to use e-books with more effective designs for literacy development have also increased (Neuman, 2009). The effect of e-books on improving the literacy skills of typical readers has been proven in many studies (Chen, 2022; Janawati et al., 2022; Korat et al., 2022a, b; Lim et al., 2021; López-Escribano et al., 2021; Merkle et al., 2022; Saripudin et al., 2022). In different studies, it has been reported that e-books support reading motivation (Dwijayanti & Sihombing, 2021), initial literacy skills (Segers et al., 2006), vocabulary and vocabulary knowledge (Shamir & Baruch, 2012; Shamir & Maor, 2019; Shamir et al., 2012), phonological awareness (Shamir et al., 2012) and writing skills (Curcic & Johnstone, 2016) of students with reading difficulties.

There are various studies, albeit limited, examining the use of e-books in specific learning disabilities. These studies focus on the effects of e-books on language development, literacy and maths skills, and their potential benefits in education compared to printed books. The studies were mostly conducted with pre-school students, and a limited number of studies examined university and high school students. For example, Shamir et al. (2018) worked with 77 kindergarten students at risk of learning disabilities and examined the effect of an activity involving an educational electronic book (e-book) on language retention in children at risk of learning disabilities. At the end of the study, it was observed that the activity with the e-book had a long-term effect on the vocabulary of the children, and in terms of story comprehension, an increase in the recall of the main ideas was observed in the long term, while the level of recall of words and quotations decreased. In another study conducted by Shamir (2017) with kindergarten students at risk of learning disabilities, it was observed that the presence of metacognitive guidance in the educational e-book supported phonological awareness but did not support vocabulary acquisition. In another similar study, it was found that the presence of metacognitive guidance in e-books significantly improved literacy and numeracy skills in kindergarten students at risk of learning disabilities compared to e-books without guidance (Shamir & Lifshitz, 2013). Another study examining the effect of e-books on the mathematics skills of kindergarten students at risk of learning disabilities was conducted by Segal-Drori et al. (2019) At the end of the study in which kindergarten students at risk of learning disabilities and normally developing kindergarten students were compared, it was found that an electronic storybook with mathematics content significantly improved the emerging mathematics skills in both groups compared to normal kindergarten activities. In another study on the use of e-books for preschool children at risk of learning disabilities, it was stated that e-books significantly improved children's vocabulary and phonological awareness compared to printed versions read by adults (Shamir et al., 2012).

In studies comparing preschool children at risk of learning disabilities with children with normal development in terms of e-book use, it was concluded that e-book

activity significantly improved children's vocabulary and phonological awareness in both groups, however, children with normal development were able to get higher scores in terms of story comprehension (Shamir & Korat, 2015; Shamir & Shlafer, 2011; Shamir et al., 2011). There are studies on the use of e-books in individuals with specific learning disabilities not only with preschool children but also with adults. For example, in the study conducted by Cavalli et al. (2019) with university students, the effects of printed and e-books on the reading comprehension skills of dyslexic and non-dyslexic adults were compared. It was observed that dyslexic individuals performed as well as or better than non-dyslexic individuals in printed books, but reading e-books can be limiting for dyslexic individuals in terms of reading comprehension. Regarding these results, the researchers stated that some clues in printed books are useful for dyslexic individuals and that they perform quite well in understanding printed books when there is no time pressure. Therefore, it was stated that if menus, search buttons, etc. are provided in e-books to facilitate reading, dyslexic individuals can also achieve good results in these books, but these features were not addressed in the study. In another study supporting this view, e-book and printed book formats were compared in terms of reading comprehension levels and reading speed of dyslexic high school students. At the end of the study, it was observed that the use of e-book reader devices significantly increased speed and comprehension when compared to traditional presentations in printed format (Schneps et al., 2013). Therefore, it can be said that e-books can be a valuable educational tool for children and adults with specific learning disabilities, but learning experiences can be further improved with some arrangements that should be taken into consideration in the design of e-books.

In reading interventions for students with learning disabilities, it is stated that computer-assisted instruction effectively improves their reading skills, especially word recognition, comprehension, language/word knowledge and pre-reading skills (Hall et al., 2000). One of the related studies was conducted by Mioduser et al. (2000) and computer-based instruction was compared with traditional teaching methods (textbooks and teacher instruction). At the end of the study, it was found that computer-based instruction significantly improved early reading skills in preschool children with high risk of learning disabilities. In a longitudinal study conducted by Fälth et al. (2013), the effect of computer-assisted interventions in improving the reading comprehension skills of 2nd grade students with reading difficulties was examined. In the study, three groups of children with reading difficulties received computer-assisted instruction and one of them used a programme that aimed to improve word decoding skills and phonological abilities, while the second group used a programme that focused on word and sentence levels. The third group received a combination of these two programmes, while a fourth group receiving traditional instruction also participated in the study. According to the results, while the reading skills of all groups improved, the students in the third group who received the combined computer-assisted instruction programme showed more improvement and it was even decided that most of the students in this group no longer needed special education one year after the intervention. Another study examining the effect of computer-assisted instruction on improving the reading comprehension skills of students with learning disabilities was conducted by Kim et al. (2017). At the end

of the study, it was stated that computer-assisted instruction can improve reading comprehension skills of students with learning disabilities when it offers opportunities for practice, self-correction and immediate feedback, teacher-directed instruction, and opportunities to increase student motivation and participation. Srivastava and Haider (2017) developed a personalised e-learning platform with an assessment model that examines the cognitive potential of dyslexic students and thus aims to alleviate their alphabetic problems. This platform specifically targeted dyslexic primary school students between the ages of 6–9 and was evaluated by taking the opinions of special education experts in this field. According to the expert opinions, it was stated that such a platform could be useful for dyslexic children, but the system should be improved with more learning objects and feedback in line with the results to be obtained with experimental studies.

There are also various studies examining the effectiveness of incorporating assistive technologies into teaching processes in order to improve the reading skills of individuals with learning disabilities. For example, Svensson et al. (2019) examined the effects of assistive technologies on elementary school students with advanced reading difficulties by supporting them with various applications (speech-to-text, text-to-speech, scanning from written text to digi-talised text, audiobook reader, word game, etc.) developed to facilitate reading-writing processes. At the end of the study, it was stated that the use of assistive technology was supportive for individuals with reading difficulties, that it was effective in improving their text assimilation and reading skills even though they did not use traditional remediation methods, that it increased their motivation for general school work and that these effects were sustained. Similarly, Nordström et al. (2018) stated in their study that when various reading and writing applications (speech-to-text, text-to-speech) were used as assistive technology, students with reading difficulties improved both in assimilating text (i.e. reading) and communicating (i.e. writing). It was also stated in this study that such assistive technologies can encourage students to participate in regular education. In another study in which the effect of text-to-speech application as an assistive technology on reading in children with reading difficulties was examined, similar results were obtained and it was seen that this technology increased the reading speed of children with reading difficulties. However, when looking at its effect on reading comprehension, significant improvement was observed in young children (3-5th grade), while no effect was observed in older age groups (6-9th grade) (Gruner et al., 2018). In a case study examining the views of an occupational therapist with experience in school about the support of assistive technologies to meet the needs of students with learning disabilities in reading and writing, it was found that these students were not able to use assistive technology (McIever et al., 2023). When the studies conducted are examined, it is seen that computer-assisted instruction and various assistive technologies play an important role in improving the reading skills of individuals with learning disabilities, and with this, the motivation of individuals to participate in educational processes increases.

Although the positive results of the studies are promising, the sustainable features of the developed environments can be considered weak due to their systematic, limited content and structures that are not associated with the theoretical basis. The aim of this study is to develop, improve, implement and test the effectiveness of a

CBT-based e-book (DIJIKIT) to be used in improving the reading skills of primary school students with LD. Within the framework of this purpose, DIJIKIT will be created with design-based research (DBR). The effectiveness of DIJIKIT on reading skills (reading comprehension and reading level) will be examined within the scope of single-subject experimental design. Within the framework of the aim of the research, the following research questions were sought to be answered:

1. What are the properties of DIJIKIT? (DBR)
2. Do DIJIKIT and printed material applications differ in terms of effectiveness in improving the reading comprehension skills of primary school students with LD? (Experimental)
3. Do DIJIKIT and printed material applications differ in terms of effectiveness in improving the reading levels of primary school students with LD? (Experimental)
4. What are the social validity views of special education teachers and parents on the effect of DIJIKIT on the reading comprehension skills of primary school students with LD? (Experimental)
5. What are the social validity views of special education teachers and parents on the effect of DIJIKIT on the reading level of primary school students with LD (Experimental)

2 Method

The study was planned in a two-stage research process and the design, development and improvement of DIJIKIT was carried out within the framework of DBR procedure. The effectiveness of DIJIKIT was analysed within the scope of single-subject experimental design. The reasons that necessitated two different research methods can be listed as follows: (1) the development process of the materials produced for children with LD is not complete and not open to modification, (2) the characteristics and needs of the target group are not well reflected in the design processes.

3 Study 1

DBR, which is planned as the first stage of the study, can be considered as a hybrid methodology that brings designers and researchers together in a joint effort. DBR is effective in producing innovative, contemporary and effective solutions to learning problems or needs by combining current, effective design principles with innovative technologies (Cobb et al., 2003; Gustafson, 2002; Reeves, 2006). Through this approach, theory can be developed, instructional design process is supported, applicability and quality of research results are increased (Cobb et al., 2003). DBR plays an important role in the development, implementation and sustainability of innovative teaching interventions (Design-Based Research Collective, 2003). The most important reason why DBR is preferred is that the researcher carries out the process together with the participants and the participants have a share in critical decisions in the process (Cobb et al., 2003). It is possible to say that it is inevitable

to be up-to-date and innovative since continuous improvement will be made in the effective intervention environment to be developed in DBR. It has been stated that experimental studies are insufficient in the design of effective teaching environments and this creates a loss of confidence for practitioners and researchers (Levin & O'Donnell, 1999). At the point of being able to work on contexts and design truly effective and sustainable systems, DBR has a profile that includes creative and productive processes that make the designer and researcher work together (Bakker, 2019; Barab & Squire, 2016).

Within the scope of DBR, which constitutes the first stage of the research, the design and improvement of DIJIKIT was realized. DIJIKIT sample design was created to start the DBR cycles. This design was created by the researchers as a result of literature review, expert opinions and interviews with instructional designers. The integration of CBT into DIJIKIT (design principles, activities, etc.) was completed within the scope of DBR. The writing and control of the texts in DIJIKIT were also completed in DBR. A sample story text was written by the researchers and then checked and edited by a linguist. After the writing, checking and editing of the sample text was completed, CBT-based activities were planned. The activities and the sample text belonging to the stages of relating, experiencing, practicing, collaborating and transferring were digitized with e-book development software (Adobe Indesign). A total of three DBR cycles, including this design, were conducted and DIJIKIT, which was determined as ready for use in the last cycle, was examined in the experimental process. The changes made to the design according to the feedback received during the DBR cycles were as follows: First cycle: Text illegibility (size), on-page layouts, color choices, volume levels. Second cycle: Design of buttons, adjustable volume levels, some color changes, element sizing. Third cycle: Adding backgrounds to texts. The general DBR structure followed in the study can be seen in Fig. 1.

The participants in the DBR process of the study consisted of the researchers, three special education teachers, two primary school students with LD, and three

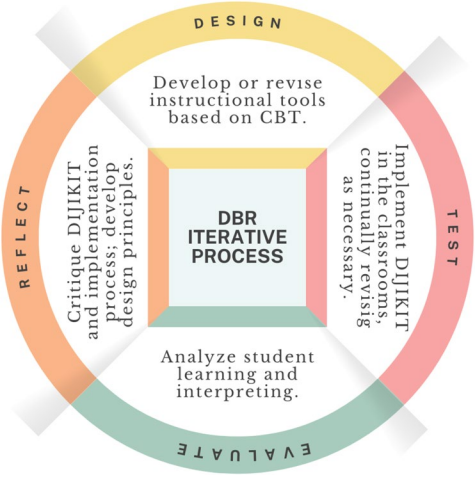

Fig. 1 DBR flowchart

academicians working on LD and reading. **Researchers** consisted of three researchers who designed and conducted this research. The researchers hold doctoral degrees in instructional technology. The researchers at DBR played a central role in both designing the intervention and collecting and analyzing the data. They also acted as facilitators ensuring that the process was collaborative and aligned with theoretical frameworks. **Special education teachers** are crucial in DBR as they bring practical knowledge and expertise about the classroom environment, student needs and teaching strategies. Two special education teachers who have been or are currently involved in teaching with LD students were involved in this process. Both teachers have a bachelor's degree in special education and are actively working in special education institutions. **Students** consisted of students diagnosed with LD who are the direct beneficiaries of the intervention to be developed, two students diagnosed only with LD, two students with no other special education diagnosis and two students who benefit from the national right to education as mainstreamed students. **Academicians**, academics working on LD and reading, provided expert knowledge and theoretical insight in the development and evaluation of the intervention. Their role included reviewing the literature, guiding the methodological approach and ensuring that the training strategies were based on current research on learning disabilities. Three academics participated in the first phase of the study on a voluntary basis.

4 Study 2

4.1 Participants and settings

The participants were three primary school students who benefited from special education services in line with national education services (https://orgm.meb.gov.tr/) in the central residential area in the eastern region of Turkey. The students were included in the study according to the following criteria: (1) The participant had only a diagnosis of LD, (2) The participant could correctly touch the target area on a touch screen, (3) The participant's learning problems were not caused by a physical reason (e.g. visual, hearing or motor), and (4) Parental consent was obtained. In addition, each student's difficulties in the reading process in the individualised education programme were also indicated by his/her teachers. And the accuracy of the LD report issued by the national institution is accepted. The information of the participants after observation and interview can be listed as follows:

> **Mustafa** was diagnosed with LD at the age of 7. He often has difficulties with letter recognition and decoding, as a result of which his reading speed decreases and he has difficulty in understanding written materials. Mustafa's family comes from a middle socioeconomic background. His parents work. They are willing to help but struggle to understand how to deal with his difficulties at home. Mustafa is reluctant to participate in reading tasks and is often frustrated. Teachers noted that his reading comprehension improved when additional support was provided, such as verbal explanations and visual aids.

Kemal was diagnosed with LD at the age of 6. He has an identified learning disability that affects both his reading and maths skills. He has difficulty following complex instructions and often requires tasks to be broken down into smaller steps. Kemal's family has a middle socio-economic profile. Kemal can read simple texts with moderate fluency but struggles with more complex vocabulary and sentence structures. He often needs help in breaking down paragraphs to understand meaning.
Ata was diagnosed with LD at the age of 7. Ata can read at grade level but has difficulty remembering due to distractibility. He often reads aloud in class but may not remember material well unless it is reviewed repeatedly. Ata's family is upper-middle class. His parents are proactive about his education, often liaising with teachers.

As a participant, the effectiveness of the materials and the implementation process was also supported by social validity data. Social validity data were collected from special education teachers ($n=11$) and parents ($n=3$) who taught Mustafa, Kemal and Ata in special education. Special education teachers and parents volunteered to participate for social validity data. The social validity form described data source triangulation, which aimed to assess how the intervention was perceived by the participants and its appropriateness from the perspective of teachers and parents. These participants were selected through purposive sampling because it was important that they knew the students affected by the intervention and had observed their reading process. Social validity data were collected through individually scheduled face-to-face interviews and by asking questions on social validity forms. The interviews lasted an average of 48 min. Data were recorded with audio recordings and researcher notes.

4.2 Dependent measures

Reading comprehension and reading level scores were the two dependent criteria of the study. The students' responses to the reading comprehension questions about the story texts were recorded and scored. In this scoring, The Informal Reading Inventory (IRI) adapted into Turkish by Akyol (2010) will be used. IRI is a standardised test and measures reading behaviour. It is a reading assessment tool that can measure the development in the reader's reading skills (Clay, 1993). With IRI, changes in reading behaviour of students who have difficulty in reading can be easily measured. Simple and inferential questions are used to determine the comprehension level of the student. Two simple level and three inferential questions are prepared for each text. The scoring level is determined for each level question. Scoring for simple questions is as follows: 2 points for a fully answered question, 1 point for an incompletely answered question, and 0 points for an incorrectly answered or not answered question. The scoring for inferential questions is as follows: 3 points for a fully answered question, 2 points for a question with more than half of the answer, 1 point for a question with half/incomplete answer, 0 points for a question answered incorrectly or not answered at all. The maximum score that can be obtained and the

score obtained by the student is calculated as a percentage. This percentage value will give the student's reading comprehension rate.

In order to calculate the reading level, an assessment is made within the scope of three levels: anxiety level, instructional level and free level. In order to calculate this value, the student's errors in the reading process and the reading comprehension percentage value are used and matching is made from the table in IRI. Accordingly, the student's reading level will be determined. At the free reading level, the student has a word recognition score of over 99% and a comprehension score of 90%; at the instructional level, the student has a word recognition score of 95–98% and a comprehension score of 75–89%; at the acquisition level, the student has a word recognition score of less than 89% and a comprehension score of less than 75%.

4.3 Procedures

The second phase of the study, the single-subject experimental process, was conducted within the framework of adaptive alternating treatments design. The experimental conditions of the study were as follows: baseline, training process, DB (i.e., e-book independent of CBT) and DIJIKIT (i.e., e-book with CBT strategies integrated), follow-up sessions. The first author collected baseline data and delivered the intervention to three students individually. Students' reading comprehension and reading level performance scores were collected at the end of each session.

4.4 Baseline

The baseline included three sessions conducted individually with three students, and each session began with instruction to the student:

> *Please read this story carefully. You can read it once out loud and once silently. Then I'll ask you some questions about the story. You can start.*

While the student read the story aloud, reading errors and reading time were recorded. Then, the student read the story silently once and was asked questions about the story. The questions were three surface and three inferential questions about the story. The participant data collected in the baseline sessions were expected to show a consistent trend over the three sessions. If a consistent trend is not obtained during the three sessions, the number of baseline sessions will be increased. Although Tekin-İftar (2012) states that baseline session data is not mandatory for the design of adaptive transformational interventions, they still recommend collecting baseline session data in order to provide more reliable interpretations and evidence of change. The training process is the stage where training is provided to both participants, interventionists and observers. Participants were provided with a sample module and short exercises on how to click somewhere on the tablet and how to use the keyboard and mouse at a basic level. Thanks to this training provided to the participants, any usage problems were prevented during the implementation sessions.

4.5 DB instruction

DB instruction includes the digitalisation of the texts written about each letter and multimedia components that are voiced and animated. There are 29 modules for 29 stories for 29 letters in the Turkish alphabet. The student selects a letter in the DB instruction process and can read, listen or listen to the story about the letter on the screen or use the animated version of the story.

4.6 DIJIKIT instruction

DIJIKIT instruction includes the digitalisation of texts written about each letter, voice-over, animations and CBT-based activities and enriched content. There are 29 stories for 29 letters in the Turkish alphabet and the stories are different from the DB content. The stories are of similar length and difficulty, but the content is different. The student using DIJIKIT learns the story through relating, experiencing, practising, collaborating and transferring activities.

4.7 Treatment ıntegrity

The researchers created an implementation checklist that included all the steps to be followed in the sessions. The first author videotaped all sessions (with the permission of the participant, institutional administrator, parents and teachers) to check the fidelity of the implementation. It will be observed that the intervention exhibits the expected behaviours similarly in each session. Implementation fidelity data were analysed using the formula "[(Observed implementer behaviour/Planned implementer behaviour) × 100]" (Billingsley et al., 1980). We calculated implementation integrity as 100% in all teaching sessions.

4.8 Interobserver agreement

Interobserver agreement was achieved in 100% of the sessions. Three researchers scored all transcribed student reading comprehension and reading level responses. Prior to scoring, the researchers reviewed and discussed the procedures in detail and practised scoring. Inter-rater reliability data were analysed using the formula "[Agreement/(Agreement + Disagreement) × 100]" (Kazdin, 1982). We calculated 98% inter-observer agreement for the recalled text.

4.9 Experimental design

A randomized alternating treatment design was used in the study. The alternating treatment design allowed us to directly compare the unique effects of the e-book supported by the CBT-based strategy on reading comprehension and reading level by rapidly alternating the two experimental conditions. In this design, each participant began with three baseline sessions followed by the alternating treatment condition, which directly compared the effects of the two types of intervention on reading

comprehension skills and reading level. In single-subject studies, it is possible to examine the effect of instructional interventions on a specified behavior or behaviors, in which participant performance is assessed individually, when there is no generalization aim and participants cannot be grouped into a homogeneous group. This model allows to examine the effects of two or more independent variables on two or more dependent variables (Rakap, 2017). The reason why this model is preferred is that functionally similar but independent materials will be used for each subject. In order to evaluate the effectiveness of DIJIKIT apart from the reasons of being a different and new application, a e-book without context-based activities will be used with DIJIKIT. Two different applications were presented sequentially and their effectiveness was analyzed. In this way, there was no problem in distinguishing the return of behaviors and the effects of practices in the adaptive alternating practices model (Tekin-İftar, 2012). Equal number of sessions and trials were included for both instructional interventions. It was foreseen that some factors may threaten the internal validity of the experimental process. Factors such as loss of participants, measurement, external factors and transport are among these factors. In order to ensure internal validity, the parents and teachers of the students will be interviewed before the application starts and they will be told not to tend towards reading more letters, syllables, words and sentences than the normal teaching processes and similar interventions may affect the results of the research. While determining the students for the loss of participants, they were selected among those who regularly attended the lessons in the institution. In addition, three students were determined as substitute participants in case there were any students who had to leave the application for any reason during the application. Inter-observer reliability data were collected in at least 40% of all sessions to be conducted throughout the research, and thus the measurement threat was taken under control.

5 Analysis

Effectiveness data were converted into percentages and analysed by visual analysis and calculation of effect sizes. The data obtained in the sessions were calculated by taking into account the degree of slope and stability level within and between phases. Visual analysis is a method used in single-subject research. Visual analyses help the researcher to examine the data carefully, to examine the effectiveness of independent variables on dependent variables and to make judgements about the level of this effectiveness. Some factors should be taken into consideration when analysing the data: The change in the level of the dependent variable, the gradual increase or decrease in the dependent variables throughout the observation, and the changes in the dependent variables after the condition change (Jhangiani et al., 2019). Visual analysis alone was insufficient to determine the effect between the intervention and reading comprehension and reading level development in the study. The Tau-U index (Parker et al., 2011) was calculated for the effect sizes of the data, i.e. to determine the strength of the DIJIKIT intervention. Tau-U is a non-parametric statistical evaluation used in the calculation of the effect size that combines the slope in the intervention phase and the data that do not overlap between the two phases

(baseline-intervention) (Parker et al., 2011). Tau-U, which takes any value between 0–1, is considered to have a large effect between 0.93–1, a medium effect between 0.66–0.92 and a small effect between 0- 0.65 (Parker et al., 2011). Session data for each participant were first entered into an Excel spreadsheet and then into an online effect size calculator. The website https://singlecaseresearch.org/calculators/tau-u/ was used to calculate the Tau-u value.

In the analysis of social validity data, thematic analysis method (Creswell, 2010) was used and MAXQDA software was used for the analysis. The reason why the thematic analysis method was preferred was that the content of the questions to be directed to teachers and parents was determined. It is only necessary to reveal the similarities or differences between the themes of the questions received from teachers and parents and to verify the themes. For the thematic analysis, the analysis procedure suggested by Braun and Clarke (2006) was applied in six phases: (1) familiarisation with the data (2) generating initial codes, (3) generating themes and sub-themes, (4) reviewing potential themes and sub-themes (5) defining and naming theme (6) producing the report. What is done at these stages can be summarized as follows: **Familiarisation with the data** stage describes the repeated reading of the data to become familiar with the whole data set. Transcribing by hand is very useful because the researcher internalizes the data in a deep way. Orthographic transcription of the data also helps to avoid omitting important details in the data (Clarke & Braun, 2013). At this stage, the data were listened to once more before being transcribed, and this process was carried out separately by three researchers. There was no note-taking or writing at this stage. This stage was done for all researchers to develop an understanding of the data. Subsequently, all the data were transcribed by the researchers- independently- manually. After all researchers transcribed all the data, these transcripts were read by the researchers alternately. Notes were taken on the transcripts. All approaches to the data and the data collection process, both analytical and reflective, were noted by the researchers. As these notes were thought to be helpful for coding, they remained in the main document and were not deleted. **Generating initial codes** is the basic building block of theme generation (Braun and Clarke, 2012). Care was taken to ensure that the codes were short and clear and could explain the commonalities and differences between the data sets (Braun et al., 2016). All data were pre-coded by the researchers. These codes were completed by adding explanations via Office Word. Overlapping and contrasting themes were organized by the researchers coming together and thinking together. **In the generating themes and sub-themes** stage, the codes were reviewed and analyzed to generate themes and sub-themes. The researchers took notes and discussed that the codes were related and differentiated from each other. Care was taken to ensure that the themes were distinctive and that the entire data set was explained with themes and sub-themes in a connected way. After the codes were identified as the first candidate themes, a thematic map was created manually. On this map, the related ones were combined and the main theme name was generated. In this way, sub-themes and themes were conceptualized. **In the reviewing potential themes and sub-themes** stage, codes, themes and sub-themes were reviewed again. Adjustments, if any, and opinions were discussed and joint decisions were implemented. Three researchers reviewed potential themes together. The nature, boundaries and scope of the theme

were discussed. The appropriateness of the themes according to the research questions was also checked and necessary adjustments were made. The final thematic framework was determined jointly by the three researchers. **In the defining and naming theme** stage, a detailed analysis of the thematic framework was created. Explainability of the themes was ensured for the research questions. **In the producing the report**, the themes were visually organized for the understandability of the study and the report was added.

6 Findings

The DBR process included a data collection and analysis process in which the design and content features of DIJIKIT were determined. Opinions and features of DIJIKIT were presented (Study 1). Students' reading comprehension and reading level scores were collected and analysed with IRI. Visual analyses and results with Tau-u values were presented (Study 2).

6.1 Study 1: Decisions of cycle of DBR and design of DIJIKIT

The DBR process includes three designs and improvements were made by the researchers for these designs. Full details of the DBR cycles are given in Table 1.

With reference to Table 1, it can be seen that improvements have been made within the scope of three cycles. The following figures show before-and-after examples of the revisions made (Fig. 2, Fig. 3).

DIJIKITmaterial, which was developed to support the reading skills of students with LD and whose effectiveness was tested, was developed within the framework of context-based approach. 29 separate modules were created for 29 letters. The structure of a module in DIJIKIT is visualised in Fig. 4.

In the relation stage, the content of the story is presented within the framework of a context from daily life and short questions are asked to establish a relationship between daily life and the story. By presenting an introductory context to the student, it is ensured that the student realises that the learning process has begun. In the experiencing phase, students are prepared to find the answers by learning the relevant concepts. In the practising stage, activities are carried out to develop connections between the questions and information in the text. In the collaboration phase, students apply what they have learnt on new problem situations in collaboration. In this phase, three primary school students with LD will log in to DIJIKIT online through the session defined for them in order to provide peer interaction. The transfer phase includes different scenarios in which the generalisability and applicability of the knowledge learnt is demonstrated and a summary of the scope of the whole content is given. The stories are based on themes such as taking responsibility, helpfulness and honesty. It is known that very long texts create disadvantageous learning processes for students with LD. For the length of the texts, the stories were written by calculating the text difficulty level. This text difficulty value is obtained by a calculation made by Ateşman (1997) based on the number of syllables, words and

Table 1 Design suggestions and improvements to the DBR process

Cycle no	Review of the material and comments						Improvements
	LD students	Academicians	Special education teachers	Instructional designers	Software developer	Language specialist	Researchers
1	Small text sizes, Too many colors on the page	Low sound levels, Updating text sizes in proportion to the page	The need to regulate sound levels, Adjustments to the placement of some elements on the page, Updating text sizing,	Elimination of background noise in sounds,	Late loading of the page,	Stories without problems	Text illegibility (size), color choices, volume levels, adjustments to page design
2	Enlargement of buttons (difficult to click)	Sizing of elements on the page,	The volume can be adjusted according to the student's wishes,	-	-	-	Design of buttons, adjustable volume levels, some color changes, element sizing
3	-	-	Adding text backgrounds for easy reading of texts	-	-	-	Adding backgrounds to texts

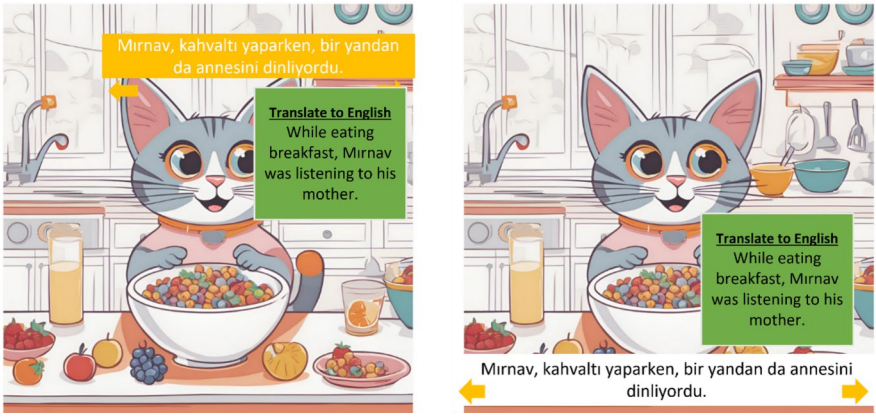

Fig. 2 Example of updates to text content and page advance buttons

Fig. 3 Example of updates in text size, positioning and colours on activity pages

sentences. If the value obtained as a result of the calculation (OS value) is between 1–29, it is decided to be a text with a readability level of "very difficult", between 30–49, "difficult", between 50–69, "medium", between 70–89, "easy" and between 90–100, "very easy". DIJIKIT is composed entirely of texts at the intermediate level. The screenshot from the story "Be hardworking" is in Fig. 5.

In each cycle, students, teachers and academics used the draft DIJIKIT and provided feedback. The feedback was reviewed, analyzed and edited by the researchers. The changes and modifications made in the cycles are as follows: In the first cycle of DBR, sample stories, multimedia components of the story were produced and combined in the digital environment. Changes were required and

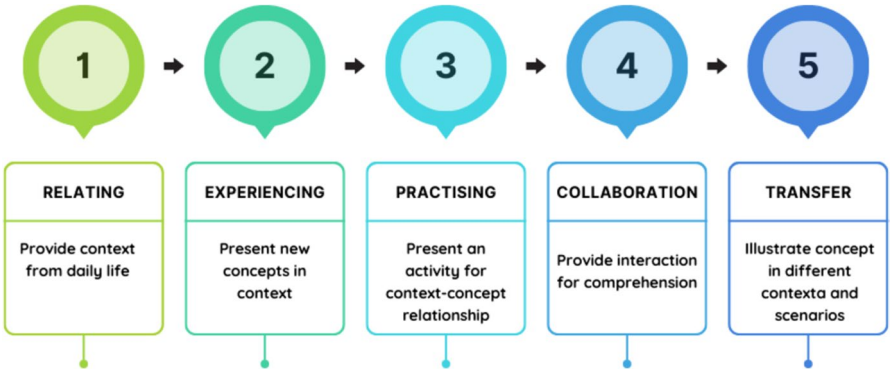

Fig. 4 DIJIKIT flowchart

Fig. 5 Screenshot of animations

adjustments were made in terms of visual placement, text formats and sizes, and the number of sentences on the pages. In the second cycle, changes were made to some of the emphasis words in the stories, and changes were made to the buttons and directions on the pages. In the last cycle, it was decided to have at least one and at most three sentences per page in all stories. The click sound on the buttons was removed and the level of the voiceover sound was made adjustable. A total of 58 stories, 29 for DB and 29 for DIJIKIT, were digitized and the DBR process was completed.

The participants of the study in the DBR process consisted of the researchers, three special education teachers, two primary school students with LD, and three academics working on LD and reading. The features of DIJIKIT were decided in three cycles as color choices, characters, voice-over, story titles, story topics, and CBT activities. The opinions obtained from students, teachers, academics and researchers were categorized into themes and sub-themes as a result of thematic analysis. Figures 6, 7 and 8 show the thematic analysis results for DIJIKIT features.

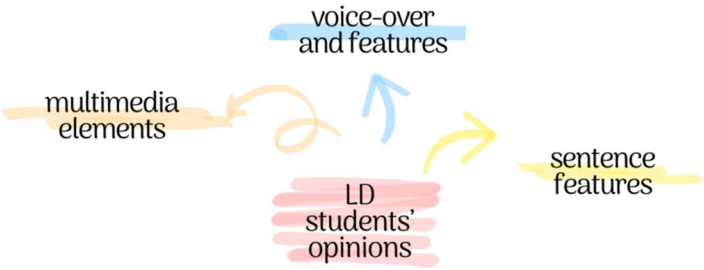

Fig. 6 Thematic analysis results of the LD students' opinions on the features of DIJIKIT

Fig. 7 Thematic analysis results of the special education teachers' opinions on the features of DIJIKIT

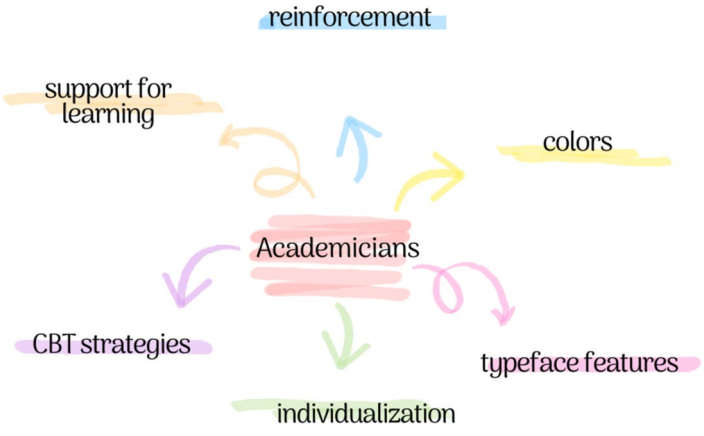

Fig. 8 Thematic analysis results of the academicians' opinions on the features of DIJIKIT

LD students expressed their views under three main themes. Under the Multimedia elements theme: Visuals, Characters, Animations, Voice-over, Songs. Under the theme of Voice-over and features: children's voices. Under the theme of Sentence features: Short sentences with few words and Transition from known to unknown words were included. Some direct quotations from student views on the features of DIJIKIT are presented.

"I learned many new words, starting from the words I know and moving towards new words I don't know" (Mustafa/Sentence features)
"I had a lot of fun listening to the stories, I liked that I could mute the sound when I wanted to read them myself." (Kemal/Voice-over and features)
"There were pictures of everything in the stories, very cute characters were drawn. I felt like I was watching the same cartoon." (Ata/Multimedia elements)

Some direct quotations from the views of special education teachers on the features of DIJIKIT are presented.

"I think it's a great component to have the story read properly by an adult imitating the child's voice. Children model a voice like their own but better" (Special education teacher: SET3/voice-over features)
"It was a very good design feature that the lengths of the stories were considered according to student characteristics, that they did not bore the students and that the flow and lengths of all the stories were consistent with each other... The fact that the stories were created in relation to daily contexts also supported comprehensibility." (SET4/Text content)
"The student is not kept in a profile of reading the story, but of thinking about it, discussing it, answering questions and actively taking part in story learning." (SET5/Activities)
*"The stories were memorable and fun because they were supported with visuals and activities from the context."(*SET1/Multimedia elements)
*"Learning materials such as this one, which are free, easy to download and use, should be disseminated nationally."(*SET2/Usage features)
"The pages are not filled with text, like children's storybooks, with an emphasis on focusing on the relevant pages with a few sentences." (SET4/ Sentence lenght)

Teachers expressed their views under six main themes. Under the theme of Multimedia elements: Animated elements, Colorful designs, Children's songs, Voice-over and feature: Adult voice imitating a child's voice and Child voice. Under Usage features theme:User friendly, Free and continuous use, Updated content subthemes. Under the Sentence lenght theme: Meaningful sentences, Compliance with spelling rules, Up to three sentences on pages, Use of related sentences on pages. Under the theme Text content: There are sub-themes of narrated content, Text of up to 500 words, Pedagogical appropriateness, Content related to the curriculum. Under the Activities theme: Games that support story comprehension, Question and answer activities that keep students active, Activities that provide immediate feedback, Review activities.

Some direct quotations from the opinions of academicians about the features of DIJIKIT are presented.

"Giving immediate and explanatory feedback to students teaches them how to solve the problem they experience in the reading process. In other words, there is no need for a re-evaluation process after the learning process." (Academician: AC1/Reinforcement)
"Since the colors used in the page designs are chosen from tones that do not prevent the reading of the texts, and since the background is added to the texts, the pages are designed for the reading process." (AC2/Colors)
"Typefaces that comply with the spelling rules and are also sized appropriately for the page and reading can be considered as very effective design elements." (AC4/Typeface feature)
"I can say that there is "individualized reading intervention" here, since the texts on the pages, voice-overs and activities are such that the reader can adjust them according to his/her own learning characteristics. "(AC3/Individualization)
"Since the whole reading process is given in a context, reading has become an enjoyable activity that is related to real life and consists of experiences."(AC1/CBT strategies)
"The reading process offered in DIJIKIT has the potential to keep the learner motivated to learn and to create an active reader profile. "(AC2/Support for learning)

Academics expressed their opinions under six main themes. Under the Reinforcement theme: Context-specific feedback, Explanatory feedback, Immediate feedback, Scoring system, Multimedia supported feedback. Under the Colors theme: Use of colors that do not make reading difficult, At least three colors, Consistency and harmony in design, Black or white text colors. Under the Typeface features theme: Typefaces should not be too big or too small, No additional features such as bold or italic, Alignment on the page, Writing in accordance with sentence structure, Meaningful words and sentences, Compliance with spelling rules. Under the theme of individualization: Volume adjustment, Progress at the desired speed, Opportunity to watch again, Transitions back and forth. Under the theme of CBT strategies: Making connections with prior knowledge, Learner experience, Learner-specific feedback, Repetition of learning in different contexts, Collaborative activities, Authentic learning experiences. Support for learning: Supporting understanding, Active learner role, Engaging, Increasing attention, Increasing motivation, Assessment embedded in learning, Pedagogical relevance.

6.2 Study 2: Effectiveness of DIJIKIT

For reading comprehension and reading level, both within- and between-situations visual analysis were conducted for three participants. In single-subject research, visual analysis helps to examine observed performance in terms of level, trend, variability and consistency (Kratochwill et al., 2010). All three participants had an

increasing trend in both DB and DIJIKIT. The data were supported by the Tau-u value and it was determined that the effects of the two separate interventions differed from each other. The low effect of DB and high effect of DIJIKIT revealed the difference in the CBT approach focused on.

Figure 9 shows that all three students' reading comprehension performances changed in both DIJIKIT and DB interventions. However, the increase in DIJIKIT intervention is quite high. The effectiveness of DB and DIJIKIT interventions on reading comprehension was analyzed with Tau-u value Tau-U calculations measured the non-overlap between baseline and post-intervention phases, accounting for baseline corrections (effect size estimates are according to Vannest & Ninci (2015).

The effectiveness of DB on Mustafa's reading comprehension performance is −0.17 Tau-u value and negative small size change while the effectiveness of DIJIKIT is 0.98 Tau-u value and very large size change.
The effectiveness of DB on Kemal's reading comprehension performance is −0.29 Tau-u value and negative small size change while the effectiveness of DIJIKIT is 1.0 Tau-u value and very large size change.
The effectiveness of DB on Ata's reading comprehension performance is 0.29 Tau-u value and positive small size change while the effectiveness of DIJIKIT is 0.98 Tau-u value and very large size change.

There was a change in the reading levels of all three students in both DIJIKIT and DB interventions with DB and DIJIKIT interventions. While the reading levels of all three students were at the anxiety level in the baseline sessions, Mustafa, Kemal and Ata remained at the anxiety level in the DB sessions. In DIJIKIT sessions, when the average of reading performances in all sessions was taken, Mustafa was at the Free level, Kemal was at the Instructional level and Ata was at the Free level.

The opinions of teachers and parents regarding the effectiveness of DIJIKIT were collected and analyzed as social validity data. The opinions obtained as a result of thematic analysis of social validity data can be seen in Fig. 10.

Under the two main categories of teachers and parents, the themes with blue background in Fig. 10 represent the views of teachers, the themes with yellow background represent the views of parents, and the themes with green background represent the common views of parents and teachers. Teachers stated that

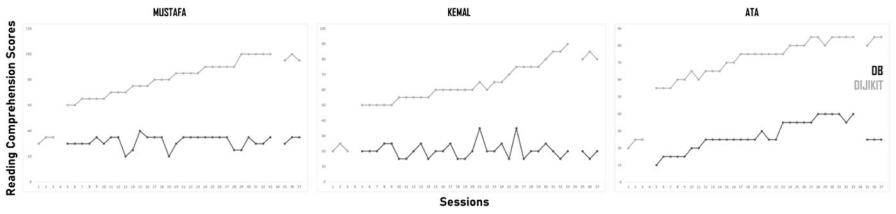

Fig. 9 Reading comprehension performances of Mustafa, Kemal and Ata in baseline, DB, DIJIKIT and follow-up sessions

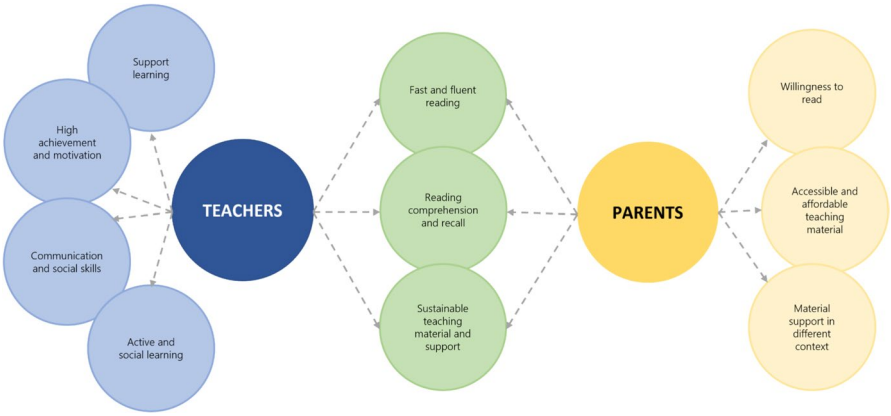

Fig. 10 Thematic analysis results of the social validity data

DIJIKIT supported with CBT supports active and social learning, communication and social skills, academic achievement and motivation, and learning. Parents emphasized that DIJIKIT supported with CBT increases the desire to read, is easily accessible material and there is a need for DIJIKIT-like materials in different contexts. Both teachers and parents stated that DIJIKIT created a sustainable teaching material and supported reading comprehension, recall, fast reading and fluent reading.

Direct quotations from teachers' opinions are as follows:

'They supported their learning process comprehensively by using DIJIKIT. This support can be considered quite sustainable."(Support learning)
'I had students who were highly motivated with similar effective materials. They also saw that they achieved high achievement in reading."(High achievement and motivation)
'Since they learnt actively with the material, the communication there was reflected in the class and among themselves.' (Communication and social skills)
'Children were in the process as living and doing the reading rather than being listeners. They engaged in dialogue and took part in the process as a social learner.' (Active and social learning)
'They read fast and fluently, incomparably faster and more fluent than their previous performance.' (Fast and fluent reading)
'Their understanding of the text has improved. Their answers to both surface and inferential comprehension questions are satisfactory."(Reading comprehension and recall)
'They use it at school, at home, in the car, everywhere and it is a timeless material.' (Sustainable teaching material and support)

Below are direct extracts from parents' comments:

'My child, who never wanted to read, now can't wait to read and can't wait to open DIKIJIT. For the first time he asked me to order a book for him.' (Willingness to read)
'We do not know what effective resources are. Therefore, materials that are so easy to use and access made our work easier.' (Accesible and affordable teaching material)
'Similar materials can be produced not only for reading but also for many different contexts.' (Material support in different context)
'My son now reads faster, more fluent and comprehensible. I noticed this, and I am sure the teachers noticed it too.' (Fast and fluent reading)
'We can have a conversation about what he reads because he now understands and recalls the text better.' (Reading comprehension and recall)
'I think this material can be used continuously throughout the learning process.' (Sustainable teaching material and support)

6.3 Discussion

This study examined the effectiveness of DIJIKIT supported by CBT based on social perspective on the reading performance of primary school students with LD. The study was conducted in a two-stage process; the first stage covered the CBT process in which DIJIKIT was developed. The second phase covered the experimental process in which the effectiveness of DIJIKIT was examined.

At the end of the DBR process, DIJIKIT was developed with the following features. A CBT-based e-book that will support the reading of students with LD should (i) contain multimedia elements, (ii) contain meaningful, contextual sentences with attention to spelling rules, (iii) have an up-to-date, free and easy-to-use interface, (iv) contain curriculum-related, pedagogically appropriate and narrated content, (v) provide activity support for the active learner role, (vi) increase interest, attention, motivation, (vii) be supported by social learning, social constructivism-based strategies such as CBT. It is known that supporting a digital material with multimedia elements positively affects the teaching process. Especially in the reading process, supporting the text content with meaningful associations with visual, audio, video, and animation elements increases reading performance (Chambers et al., 2006; Chun & Plass, 1996; Elder-Hinshaw et al., 2006; Grasset et al., 2007; Heimann et al., 1995; Lin & Chen, 2007; Lumapenet, 2022; Omar & Bidin, 2015; Siregar et al., 2022). A multimedia book created with multimedia elements improves independent reading (Reinking& Watkins, 2000). The use of multimedia in reading interventions for individuals in need ofspecial education supports both reading and memorizing (Munir et al., 2018). When story content is presented with multimedia and combined with questioning, reading engagement, reading comprehension and vocabulary knowledge also improve (Vidal, 2022; Zhou & Yadav, 2017). In addition to reading comprehension with multimedia elements, students' creative thinking skills also improve (Nada, 2021). Especially by making multimedia elements interactive, the reading skills of students with special needs improve considerably (Khasawneh, 2023). Within the scope of social cognitive paradigm, a very good improvement was

observed on early reading skills with interactive multimedia (Nurmahanani et al., 2021). Plaewfueang and Suksakulchai (2020) reported that they supported deaf students' reading skills with an interactive multimedia program. That is, the properties of the DIJIKIT material obtained in the DBR process are generally in line with the effective material properties emphasized in different studies in the literature. The interaction, which is emphasized to a limited extent in the literature, was also the focus of this study.

The findings of the study are in line with the literature in terms of CBT's support for reading (Atmazaki, 2018; Castillo, 2008; Dori et al., 2018; Nursahak & Atmazaki, 2018; Overton, 2007; Tutal, 2023; Ültay & Çalık, 2012; Utami et al., 2023). CBT, which is focused on as the theoretical basis of the study, is one of the approaches whose positive effects on learning are frequently proven in the literature. Reading modules designed with contextualized learning support reading comprehension (Utami & Drajati, 2024). In addition, critical thinking ability and character are also improved with CBT (Lestari et al., 2021). In addition to the design principles of the e-book, CBT strategies are also very effective and important in the study. CBT can be considered as a socially based and highly effective approach to learning. CBT affects the learning process and increases student achievement (Bergmark, 2023; Codreanu et al., 2020; Deveci & Karteri, 2022; Pangemanan, 2020; Sarwinda et al., 2020; Yuwandra & Arnawa, 2020). Reading comprehension skills are supported by using contextual clue (Oclarit & Casinillo, 2021). In fact, Peets and colleagues (2022) reported the positive impact on language proficiency, reading comprehension and home literacy in bilingual children. In addition to presenting content in context, presenting content in narrative form is also very effective in terms of reading and internalizing content. With fables, reading comprehension performance can be supported and children can exhibit better reading performance (Özer Şanal & Erdem, 2023; Romdoni, 2020). In fact, in both multimedia and CBT use, the focus is on keeping the learner in the role of an active reader in his/her own reading process. The use of platforms that offer interactive content for active learning processes improves reading comprehension skills in both native and foreign language learning (Korkmaz & Öz, 2021). Collaboration with other readers through active reading tools (Roy et al., 2021) supports the internalization of the learning environment and provides authentic learning opportunities. Reading comprehension skills are positively affected by the intensive reading approach supported by both activities and collaborations (Andrés, 2020). On the assumption that reading is a social phenomenon, constructivism actually contains clues about how interventions for reading can be designed.

The collaborative-constructivism approaches suggest an improvement in how students can read better together and support reading skills (Halic et al., 2010). By collaborating with a student who reads better, i.e., through peer scaffolding strategy, a student can collaborate and read better (Wan et al., 2017). Collaboration, which is the basis of social constructivism, argues that students and educators can improve the process by helping each other in the whole learning process. Peer-supported reading interventions that focus on collaboration are structured reading interactions and improve the process (Meletiadou, 2022). The Collaborating phase emphasizes that learning will be supported through socially based and

collaborative activities. This approach is defined as scaffolding in the social constructivist paradigm. With the use of scaffolding, reading performances of students with LD are supported (Özer Şanal & Erdem, 2023; Tsuei et al., 2020). By integrating social constructivist strategies into digital technologies, different components of reading such as reading comprehension, reading accuracy, and reading fluency are supported (Moon et al., 2021). Collaborative strategic reading is a multidimensional approach to reading based on cognitive psychology and aims at a good reading process (Amjadi & Talebi, 2024). It is important to carefully study the socio-cultural dimension of learning, which has its roots in Vygotsky (1978), in the context of reading. When designing reading interventions, having a strong theoretical foundation is important for the effectiveness and sustainability of intervention programs.

At the end of the experimental process, DB and DIJIKIT were compared and focused on the effectiveness of CBT integration independent of the effect of technology. The developed DIJIKIT also included CBT strategies unlike DB. When the reading performances of three students were analyzed, it was observed that DIJIKIT had a very high effect on reading comprehension and reading level. The process of supporting reading with an e-book is in line with the results of different studies in the literature. The negative or positive small effect of DB on reading comprehension and reading level was noteworthy. The negative or positive small effect of e-books on reading (Geng et al., 2024; Korat et al., 2022a, b; Shareef, 2023; Firdausy & Prasetyo, 2020; Lim et al., 2021; Liu et al., 2020;Yang et al., 2021; Yorganci, 2022), reading comprehension (Yang et al., 2024), self-regulation (Yang et al., 2024), reading literacy (Jasrial et al., 2023), emergent literacy skills (López-Escribano et al., 2021) and supporting learning (Shareef, 2023; Virgiyanti et al., 2024). However, each research team tested their own designs on the grounds that the designs were unique to the research team and that no sustainable, guiding design principles were shared. Therefore, in order to say that e-books affect reading, it is necessary to report which features of e-books were developed. E-books for individuals with LD have been widely studied and their effectiveness reported (Atherton & Crickmore, 2022; Boyle et al., 2021; Lee, 2020; Muhibbin, 2020; Talafha & Shathili, 2023). It is necessary to define the characteristics of these students well and make good design decisions about the instructional technologies and materials they need. For this, the collaborative work of teachers, instructional designers and academicians is also very important.

This study is by no means intended to prove that printed books are not influential. Printed books have their own iconicity and are highly valued in all cultures. The study only emphasized the need for technology-enhanced content to provide a real reading experience and proved that CBT can be used for good reading performance. The changing nature of learning-reading with increasing digitalization is a critical topic of discussion that also affects the individual's cognition (Bresó-Grancha et al., 2022). Policy makers also need to take more comprehensive steps to become well literate and build a literate society for full participation in social and cultural life with technology.

6.3.1 Limitations and future research

This study needs to be considered in light of some limitations that have implications for future research. First, the participant sample may not be representative of students with different special needs and students with LD from different cultural and ethnic backgrounds. The participants were students receiving regular special education support in an urban center and their parents may have been personally motivated to persuade their children to participate in the study. The impact of any methodology with a social perspective on reading is important. Future studies should replicate this study with larger samples, in different languages, and examine the relationship between different socially-oriented strategies and reading. Secondly, it can be said that our study contains a strong methodology with a single-subject experimental design with DBR and a single-subject experimental design, but it is not sufficient to make generalizations with a comprehensive experimental process. The effects of different social-based instructional technologies can be investigated by homogenizing the sample groups as much as possible with different experimental setups. Finally, since language is shaped by culture and context, it is important to adapt similar strategies and instructional technologies to different languages and cultures when language skills, which are the basis of the research, are considered.

6.3.2 Implications for practice

It is important that DIJIKIT-like materials are supported by institutions and organizations in the national context to be developed and disseminated for different classes and courses. Such applications should be presented on platforms accessible to special education teachers and their use in the classroom should be supported. It would be promising for different research and applications to be used with students with different characteristics for reading support and to report the results. Digital materials offer great opportunities to continue education services remotely or from home, especially for obstacles such as epidemics, disasters, etc. in the global context.

7 Conclusion

In summary, DIJIKIT is an instructional technology that supports reading and is very easy to implement. This study proved that reading comprehension and reading level can be improved with DIJIKIT. It should be blended with current technological tools, taking into account the unique development of all language skills, especially within the socio-cultural paradigm. Methodologically, research with active interactions in the learning process, such as DBR for special education, should be increased. Students with LD should be continuously supported throughout their social and academic life. Giving them access to DIJIKIT-like environments will allow them to improve their academic and social life standards directly or indirectly. By providing sustainable support to these students, we can see their great potential.

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