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Is more comfortable reading possible with collaborative digital games? An experimental study

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Highlights

- When digital games are supported with collaborative activities, they become more effective teaching materials.
- Reading skills can be improved through collaborative activities.
- Peer and teacher support supports language skills.

Article Info: Research Article

Keywords: *Social constructivism, Collaboration, Digital game, Reading*

Abstract

In this study, which is based on the fact that the nature of learning is and should be understood on the basis of social constructivism, interaction and collaboration in language development are explored and digital games are discussed as an instructional technology. For digital games developed with learning in mind, the effects of educational change for learners have not yet been fully explored. The effects of digital games supported with reciprocal activities related to reading comprehension, reading motivation, and reading anxiety for science texts were investigated in this study. Eighty-five participants were randomly assigned to a group that played digital games without reciprocal activities (control group, n=43), and they were compared to a group that played digital games with reciprocal activities (experimental group, n=42), reading ten different texts over a ten-week period. The study used a quasi-experimental pretest-posttest design to compare reading comprehension, reading motivation, and reading anxiety outcomes. Considering the effectiveness of reciprocal activities, the participants who were supported by collaborative activities were more motivated and less anxious than those in the group that used the digital games without collaborative activities. These findings indicate that the use of collaborative activities should not be ignored when planning to employ the supporting role of any instructional technologies while teaching reading skills.

1. Introduction

We learn by reading, discover life, find answers to our questions or have new questions. Reading is not only one of the essential elements required to complete academic processes. We can also say that it is of critical importance in terms of adaptation to social life. Reading, which is a highly complex skill, requires the analysis, coordination, and interpretation of various sources of information (Scanlon et al., 2010). Deep learners try to create personal meaning from what they read while analyzing the underlying thoughts (Marton & Saljö, 1976). Reading is a literacy skill, and literacy skills have been described by UNESCO (2019) as integral parts of the right to education. Adapting to the age in which an individual

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lives and making sense of it is only possible if that individual is sufficiently literate. The development of critical reading skills is considered to be a central area of educational policies (Leu & Maykel, 2016). An individual who can read effectively can understand, make sense of, and question the age in which he or she lives. However, how can an individual gain reading skills? Although there are currently many strategies for teaching reading, this study focuses on reciprocal teaching (RT) because reading is a language skill and language cannot be separated from the social context. It is essential to consider the social environment for skills that are shaped in a sociocultural structure. RT can be considered as a strategy to support reading, inspired by Vygotsky's (1978) sociocultural theory, because this strategy is based on the sociocultural theory of mind, emphasizing the importance of guided learning and dialogue in students' cognitive development (Lantolf et al., 2021). It includes four stages: predicting, questioning, explaining, and summarizing (Alfassi et al., 2009; Palincsar et al., 2019). This strategy has a structure that supports individual and collaborative learning. Researchers have often preferred RT as it has a form that can be easily adapted to specialized materials and environments. The steps it involves can be easily integrated into a game and can be applied to support individual or collaborative activities. Additionally, RT is an effective strategy that is especially frequently preferred in science education and its positive effects in this regard have been reported (Apryani et al., 2022; Jacobs Hogan, 2022; Mafarja et al., 2022; Sandopa & Doyan, 2022; Shafiq, 2021; Zendler & Reile, 2018).

2. Literature

2.1. Collaboration and Reading

Language cannot exist and maintain itself without dialogue. People's interaction networks are the most effective and necessary tools for developing a language. RT also allows students to be more active in managing group dialogues (Alfassi, 1998). Therefore, RT has the potential to create a learning or dialogue environment that supports language development. Palincsar and Brown (1984) stated that this strategy is a powerful teaching strategy based on dialogue, and they believed that students could overcome their reading problems with this approach. I also predicted that students would see, internalize, and use many different aspects of language in dialogues and learn the language better in this way. RT, an approach that supports students' reading comprehension by allowing them to collaborate on shared texts, was developed by Palincsar and Brown in 1984. This strategy focuses on collaboration, groupthink, and learners providing instructional support (McAllum, 2014). Students work collaboratively on a text and try to give meaning to readers. The concept of "reciprocal" describes one's reaction to the other. RT includes the four stages of predicting, questioning, explaining, and summarizing, and students learn to use these four strategies and apply them while discussing texts with teachers and peers. Gaining meaning from the text becomes possible with dialogues. First, the teacher thinks aloud and uses explicit strategy instruction (Alfassi, 2004; Rosenshine & Meister, 1994). The summarization strategy involves identifying, explaining, and integrating keywords to draw students' attention to the text. The questioning strategy refers to how students work with questions about the text, generate questions, find answers, or make an effort to answer questions. The explaining strategy includes processes of recognizing, understanding, and decoding complex parts of the text. These strategies may entail rereading a text or asking a friend or teacher for help. The predicting strategy involves integrating newly acquired knowledge and the learner's related prior knowledge and creating a logical structure between them. Students realize that reading is a conscious and purposeful act at this stage. Furthermore, the RT strategy is associated with three essential teaching principles (Palincsar & Brown, 1984): *1) teaching reading strategies that support reading comprehension, 2) scaffolding, and 3) students practicing reading together*. These three principles point to constructivist theory. In the context of the constructivist approach, language is a sociocultural structure and it develops in interactions. With the reciprocal strategy, students share sociocultural experiences and ownership. In this context, the RT strategy is evaluated here on a constructivist basis. Students need to discuss and share their meanings in collaborative activities under the guidance or coaching of the teacher.

The teaching process starts as a teacher-centered structure but evolves into a student-centered structure. The constructivist theory refers to the zone of proximal development (ZPD). The student is involved in teaching with the support or guidance of peers or teachers who are more competent in the relevant skill or knowledge. The teacher or a more competent peer asks questions, gives reminders, and guides and supports students in their efforts to use reading strategies. Afterward, the guidance given begins to decrease, and the student starts to be more in command in a more manageable position in the learning process. If we think about this in the context of RT, the learner begins to become more proficient in the reading process. The concepts of scaffolding and ZPD can be considered as intersecting elements of constructivist theory and RT. It was this theory that has guided the learning and dialogues that are essential for students' cognitive development and the sociocultural explanation of the mind was the inspiration for RT (Chang & Lan, 2021; Lantolf et al., 2021; Okkinga et al., 2018; Vygotsky, 1978). With RT, students and teachers engage in many dialogues. With these dialogues, the texts that are read and discussed gain meaning, and both the teacher and the students are involved in many different usages of language (Palincsar, 1989). I think of RT, considered here within the scope of social constructivism, as the phased or systematized counterpart of the peer scaffolding strategy. Peer scaffolding is a strategy that positively affects language skills such as reading, grammar, or pronunciation (Alvarez et al., 2022; Ebrahimi & Sadighi, 2022; Hou et al., 2022; Ivcevic et al., 2022). In this context, RT has the potential to support both language skills and strategies involving social identity. In addition, since it is very effective in the process of teaching science content (Apryani et al., 2022; Jacobs Hogan, 2022; Mafarja et al., 2022; Sandopa & Doyan, 2022; Shafiq, 2021; Zendler & Reile, 2018), it will be valuable to determine how much it helps students in reading science texts. RT is easily adapted to digital environments and it has been reported that it supports some performances of students with its use in digital media (Ahmad et al., 2022; Hekmati, 2022; Marom, 2022; Nasr, 2022).

2.2. Digital games as learning support tools

The effects of game-based learning on learning outcomes in school curricula have not been studied much. For games to be associated with a curriculum, they need to be considered theoretically in terms of their design, development, and implementation (Oblinger, 2006). Digital games are frequently preferred technologies for science content, and positive results are reported when they are integrated into the learning process with good designs (Agbonifo et al., 2021; Chen et al., 2021a; Hussein et al., 2021; Ristanto et al., 2022; Saricam & Yildirim, 2021; Wang et al., 2022). Games integrated with knowledge and skills instead of just being activities that fill the time in a lesson can bring different approaches to the evaluation process. Collaboration, which is also emphasized in the present study, has a structure that can be integrated with games. Games have the potential to involve people in collaborative activities (Burgos et al., 2008) and have a constructivist philosophy that allows learners to perform assigned tasks in a safe environment (Becker, 2007). From a constructivist perspective, digital games can help learners explore, create meaning, share, and collaborate. It was stated by Prensky (2007) that digital games actively involve students in learning through interactive entertainment. They also support collaborative learning and complex problem-solving (Dayo et al., 2021; Sjöberg & Brooks, 2022; Sun et al., 2022; Tong et al., 2022). The building of shared knowledge is supported by social interaction and collaborative learning becomes continuous. Current technologies allow game designs that are more sophisticated than previous ones and more sensitive to pedagogical dimensions, which has also made digital games more effective (Rieber & Noah, 2008). When digital games are included in the learning process, it will be seen that they naturally add interaction to the process. They should be considered as effective learning materials with structures that can spread throughout the learning process and unite all learning stakeholders in interactions. With the addition of digital games to the curriculum, collaborative learning, interaction, problem-solving, student participation, motivation, creativity, and many high-level thinking skills will be supported (Burgos et al., 2008; Shin et al., 2012). Collaborative digital games maintain students' learning

motivation and positive attitudes and increase their academic achievement and self-efficacy thanks to opportunities to organize and share the knowledge embedded in collaborative education (Sung & Hwang, 2013). In this study, digital game technology, which has a structure that can be easily integrated with learning processes and collaboration, will be tested for its effectiveness on reading skills.

2.3. Motivation of the study and research questions

When previous studies are examined, it is seen that RT has been integrated into different digital environments and supports reading comprehension (Chu, 2021) and motivation (Chu, 2021; Huang & Yang, 2015; Wu & Chen, 2018). However, more research is needed to say whether RT offers a comfortable space for successful reading. Such research is also crucial for testing RT's ability to provide appropriate reading processes and structures conducive to high levels of motivation and low anxiety in a suitable digital learning environment. Skills develop in environments ideal for them, while they atrophy in environments that are not suitable. Reading, an important language skill, also develops with interactions. Games can be considered a unified platform for RT, as they are structures involving interactions. In this context, ten stories were produced as digital games and RT activities in this study and the digital games were played by the selected participants. Although there is no previous study in which RT was integrated into digital games for comparison, the present study has revealed significant findings. The specific research questions are as follows:

1. Is there a difference between collaboration and non-collaboration conditions regarding reading comprehension?
2. Is there a difference between collaboration and non-collaboration conditions regarding reading motivation?
3. Is there a difference between collaboration and non-collaboration conditions regarding reading anxiety?

3. Methodology

3.1. Design and participants

This study was planned with a quasi-experimental pretest-posttest design to compare reading comprehension, reading motivation, and reading anxiety outcomes. The participants included 85 middle school students (41 boys and 44 girls) aged 11-13 years. Students and their parents were asked to sign a consent form that explained the types of data to be collected and the nature of the study, and participants were informed that they could withdraw from the study at any time. Participants having not failed any courses at any grade level was a criterion for inclusion in the study. The participants were then randomly assigned into two groups: one that played the digital games without reciprocal activities (DG group; n = 43, 20 boys, 23 girls) and one that played the digital games with reciprocal activities (DG-RA group; n = 42, 21 boys, 21 girls). At the end of the study, ten participants were awarded a gift card (each worth 20 euro) in a raffle. The study design, which was structured to compare scores of the control and experimental groups, differed from others in terms of the group conditions. While no new condition is defined for the control group in most studies, the experimental group is directly exposed to a different condition. In this study, however, both groups were exposed to different conditions.

3.2. Data collection tools

In this study, the changes in reading comprehension performances, reading motivation, and reading anxiety for science texts were observed for all participants. Reading comprehension forms were created for two stories used in the pretest and posttest. These forms contained four simple and two inferential questions about the stories that were used. Two different language experts checked the language of the

stories and questions and necessary adjustments were made. A minimum score of 0 points and a maximum of 20 points could be obtained. Incorrect answers were scored as 0, incomplete/complete answers as 1, and correct/adequate answers as 2. The reading motivation scale was developed by İleri-Aydemir and Öztürk (2013). It consists of the four factors of perception of reading difficulty, reading proficiency, effort/appreciation for reading, and social aspects of reading, with a total of 22 items. The evaluation of motivation for reading was performed with a five-point Likert-type scale. The reliability coefficient of the scale for the current sample was found to be .82. The scale was administered to participants before and after the educational intervention. Finally, the reading anxiety scale was developed by Melanlıoğlu (2014). It consists of the three factors of planning the reading process, factors supporting reading, and reading comprehension and analysis, with a total of 14 items. The evaluation of reading anxiety was performed with a five-point Likert-type scale. The scale was administered to the participants before and after the educational intervention.

3.3. Data analysis

To compare the reading comprehension, reading motivation, and reading anxiety of the students in the experimental and control groups, ANOVA was used. In the analysis of the data, the assumptions that must be met to apply parametric tests were first evaluated. That is, it was examined whether the group variances were homogeneous in order to make comparisons between the groups. For this purpose, data were analyzed with the Levene statistic (Field, 2005), which was used to test the homogeneity of group variances ($F(1.31)=1.582$, $p>.05$). If the p-value obtained in such analysis is larger than .05 (p>.05), it is concluded that the group variances do not differ in a statistically significant way and the variances of the groups are homogeneous. In all analyses, eta-squared (η^2) was used to determine the effect size of the independent variable on the dependent variable. If the eta-squared (η^2) value is between .01 and .06, it signifies a small effect, while values of .06 and higher signify medium and .14 and higher signify large effect sizes (Cohen, 1988).

3.4. Research procedures

Participants in the DG group played games without RT activities. These games were produced with ten different stories and had a standard structure. The games developed for the DG group consisted of three modules: an introduction, development, and a conclusion. Each module was completed individually. The students in the DG group played the games alone with no peer interaction. Teacher interaction occurred only in informative processes at the beginning of the games. The structure of the games that the DG group played is illustrated in Figure 1.

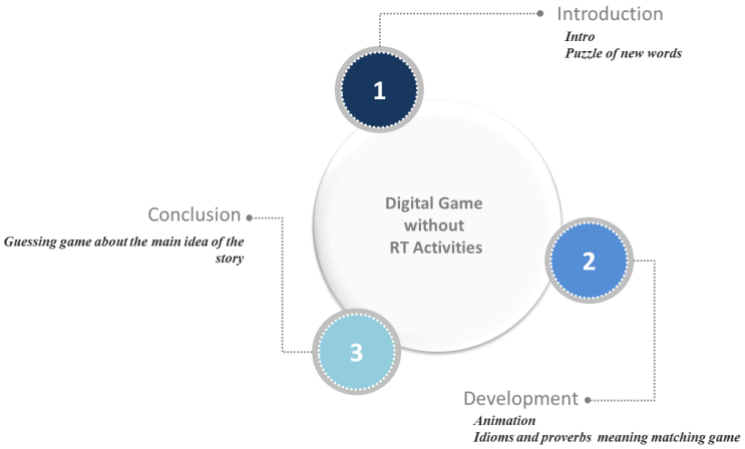

Fig. 1. Structure of digital games without RT activities

Participants in the DG-RA group played games with RT activities. These games were also produced with ten different stories and had a standard structure. The games developed for the DG-RA group consisted of four modules: predicting, clarifying, questioning, and summarizing. Each module was completed with collaborative tasks. In other words, students in the DG-RA group played the games with their peers. The structure of the games that the DG-RA group played is illustrated in Figure 2.

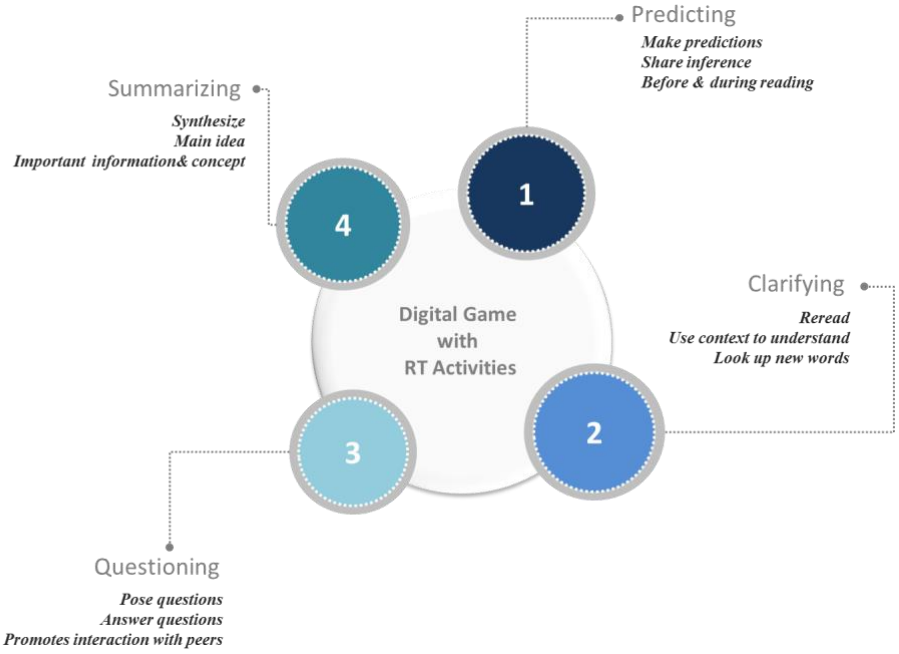

Fig. 2. Structure of digital games with RT activities

The time it took for the students in the DG and DG-RA groups to complete each game varied between 20 and 25 minutes. It was noted that the students in the experimental group did not have a significant time difference compared to the control group. While the average time for the 42 students in the experimental group to complete a game was 22 minutes and 18 seconds, the time for students in the control group to complete a game was calculated as 23 minutes and 3 seconds. No extra time was needed by either the experimental group or the control group. Both groups played games based on the same stories*: 1) Rabbit who loves to dance; 2) Elephant making pancakes; 3) Hedgehog who does not like sports; 4) Rock, paper, scissors; 5) Clouds and kangaroo; 6) The beauty of dreaming; 7) Where are the dinosaurs?; 8) Surprise at the farm; 9) Pencil and chalk; and 10) The shirt of the world.* All stories were written by the researcher. Two different language experts checked the language for all stages of the study and the necessary adjustments were made. Figure 3 summarizes the data collection procedure.

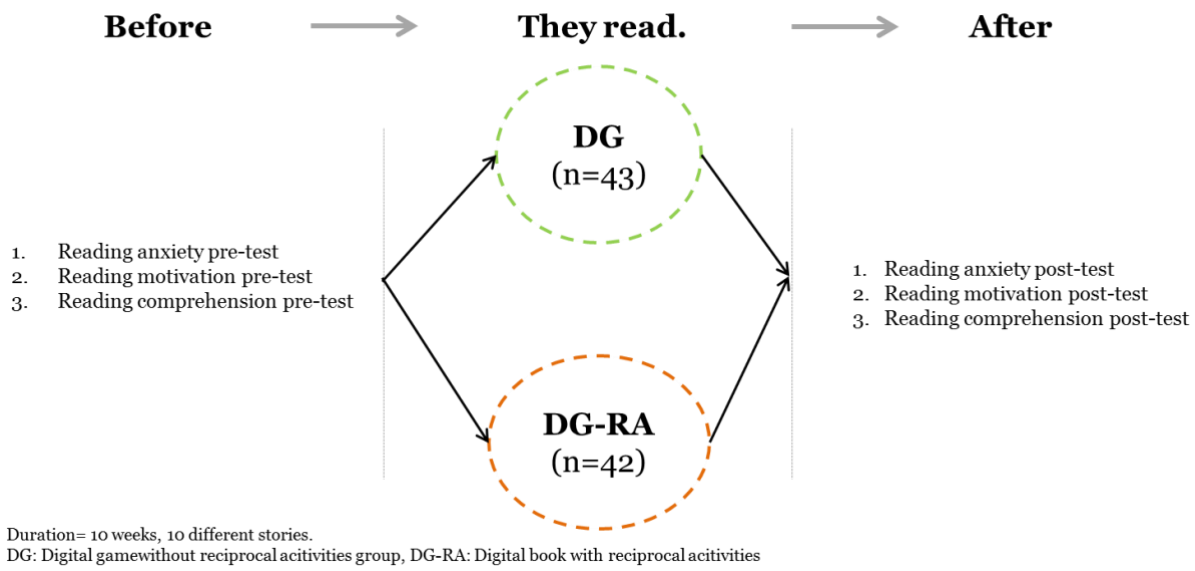

Fig. 3. Data collection procedure

4. Findings

4.1. Is there a difference between collaboration and non-collaboration conditions regarding reading comprehension?

The differences between the pretest and posttest reading comprehension total scores of the students in the DG and DG-RA groups were tested with 2 × 2 mixed ANOVA. The descriptive values of the total reading comprehension scores of these groups at different measurement times are given in Table 1.

Table 1.
Descriptive statistics for reading comprehension scores of the experimental and control groups

	Group	N	x̄	SD	SE
Pretest	Experimental	42	5.024	3.02	.47
	Control	43	4.256	2.27	.34
	Total	85	4.635	2.66	.29
Posttest	Experimental	42	15.024	3.54	.54
	Control	43	6.372	2.38	.36
	Total	85	10.647	5.28	.58

Table 2 shows the ANOVA results of the pretest and posttest reading comprehension total scores of the experimental and control groups.

Table 2.
ANOVA results of pretest and posttest reading comprehension scores of the experimental and control groups

Source of variance	SS	df	MS	F	p<	η^2
Between groups						
Intercept	9996.613	1	9996.613	878.032	.000	.914
Groups	942.636	1	942.636	82.795	.000	.499
Error	944.976	83	11.385			
Within groups						
Measurement time	1559.579	1	1559.579	339.564	.000	.804
Measurement × group	660.285	1	660.285	143.763	.000	.634
Error	381.209	83	4.593			

When the ANOVA summary table above is examined, it is seen that the factors of measurement time and group interacted and affected the total reading comprehension scores (F=82.795, p<.001, η^2=.499).

4.2. Is there a difference between collaboration and non-collaboration conditions regarding reading motivation?

To determine whether there was a difference between the pretest and posttest reading motivation scores of the students in the experimental and control groups, 2 × 2 mixed ANOVA was used. The descriptive values of the total reading motivation scores of these groups at different measurement times are given in Table 3.

Table 3.
Descriptive statistics for total motivation scores of the experimental and control groups for reading

	Group	N	x̄	SD	SE
Pretest	Experimental	42	2.437	.22	.033
	Control	43	2.351	.21	.031
	Total	85	2.394	.21	.023
Posttest	Experimental	42	3.741	.18	.028
	Control	43	2.525	.17	.026
	Total	85	3.126	.64	.069

Table 4 shows the ANOVA results of the pretest and posttest total reading motivation scores of the experimental and control groups.

Table 4.
ANOVA results of the experimental and control groups' pretest and posttest total motivation scores

Source of variance	SS	df	MS	F	p<	η^2
Between groups						
Intercept	1298.145	1	1298.145	32799.614	.000	.997
Groups	18.002	1	18.002	454.856	.000	.846
Error	3.285	83	.040			
Within groups						
Measurement time	23.209	1	23.209	640.839	.000	.885
Measurement × group	13.572	1	13.572	374.740	.000	.819
Error	3.006	83	.036			

When the ANOVA summary table above is examined, it is seen that factors of measurement time and group interacted and affected the total reading motivation scores (F=454.856, p<.001, η^2=.846). The results of 2 × 2 mixed ANOVA of the pretest and posttest scores obtained for the subdimensions of the reading motivation scale can be listed as follows: 1) The "perception of reading difficulty" total score of the experimental group differed significantly from that of the control group (p<.001). The factors of measurement time and group affected the total scores for perception of reading difficulty (F=84.099, p<.001, η^2=.503). 2) The "reading proficiency" total score of the experimental group differed significantly from that of the control group (p<.001). The factors of measurement time and group affected the total scores for reading proficiency (F=52.718, p<.001, η^2=.715). 3) The "effort/appreciation for reading" total score of the experimental group differed significantly from that of the control group (p<.001). The factors of measurement time and group affected the total scores for effort/appreciation for reading (F=41.299, p<.001, η^2=.732). 4) The "social aspects of reading" total score of the experimental group differed significantly from that of the control group (p<.001). The factors of measurement time and group affected the total scores for social aspects of reading (F=221.714, p<.001, η^2=.728).

4.3. Is there a difference between collaboration and non-collaboration conditions regarding reading anxiety?

Whether there was a difference between the pretest and posttest total reading anxiety scores of the students in the experimental and control groups was tested with 2 × 2 mixed ANOVA. The descriptive values of total reading anxiety scores of these groups at different measurement times are given in Table 5.

Table 5.
Descriptive statistics for total reading anxiety scores of the experimental and control groups

	Group	N	$\bar{x}$	SD	SE
Pretest	Experimental	42	3.51	.28	.043
	Control	43	3.60	.21	.032
	Total	85	3.55	.25	.027
Posttest	Experimental	42	1.87	.24	.037
	Control	43	3.02	.22	.034
	Total	85	2.45	.62	.067

Table 6 shows the ANOVA results of the pretest and posttest total reading anxiety scores of the experimental and control groups.

Table 6.
ANOVA results of pretest and posttest total reading anxiety scores of the experimental and control groups

Source of variance	SS	df	MS	F	p<	η^2
Between groups						
Intercept	52.651	1	52.651	2217.583	.000	.964
Groups	12.140	1	12.140	511.340	.000	.860
Error	1.971	83	.024			
Within groups						
Measurement time	1526.013	1	1526.013	16641.819	.000	.995
Measurement × group	16.146	1	16.146	176.075	.000	.680
Error	7.611	83	.092			

When the ANOVA summary table above is examined, it is seen that the factors of measurement time and group interacted and affected total reading anxiety scores ($F=511.340$, $p<.001$, $\eta^2=0.860$). The results of the 2 × 2 mixed ANOVA of the pretest and posttest scores obtained from the subdimensions of the reading anxiety scale can be listed as follows: 1) The "planning the reading process" total score of the experimental group differed significantly from that of the control group ($p<.001$). The factors of measurement time and group affected the total scores for reading process planning ($F=8.762$, $p<.001$, $\eta^2=.095$). 2) The "factors supporting reading" total score of the experimental group differed significantly from that of the control group ($p<.001$). The factors of measurement time and group interacted and affected the total scores for factors supporting reading ($F=64.730$, $p<.001$, $\eta^2=.438$). 3) The "reading comprehension and analysis" total score of the experimental group differed significantly from that of the control group ($p<.001$). Factors of measurement time and group affected the total scores for reading comprehension and analysis ($F=115.676$, $p<.001$, $\eta^2=.582$).

5. Discussion, Conclusions, and Suggestions

Different studies have been carried out to support reading skills, which have a critical role in adaptation to social and academic life. In particular, instructional technologies come to the fore in supporting reading.

However, the important thing is to design and implement that technology with a good understanding of learning, rather than just using new or experimental technology. The present study was carried out with the assumption that language skills in general and reading skills in particular can develop as a result of social interaction. Digital games were supported by reciprocal activities and were observed and analyzed with respect to how they affected readers' reading comprehension, reading motivation, and reading anxiety for science texts. The results showed that digital games supported by reciprocal activities increased the readers' reading comprehension performance and reading motivation and reduced reading anxiety for science texts. Students learned stories together through collaborative digital games prepared for ten different stories. Their tasks were completed with collaboration. In this study, which is based on social constructivism, materials were developed while primarily focusing on supporting collaboration in reading. Students constantly interacted with other students and completed collaborative tasks in the digital games for which activities were designed following the steps of RT.

Reading comprehension is a critical skill in evaluating the successful completion of reading processes. Reading, which is started by using the eyes and continues with an interactive and iterative cognitive journey, materializes with the meanings it leaves within us. In this study, the effects of digital games supported by RT were evaluated based on the assumption that reading develops with interaction and remarkable findings were obtained. Digital games supported by RT provided an effective learning environment for students to understand the texts that they read. Students achieved higher reading comprehension performances at the end of the application process. With RT, they completed tasks and worked together with their peers. These efforts brought about visible changes in their reading comprehension performances. Supporting this finding, previous studies reported that students understand reading processes better when they include interaction and collaboration (Chen et al., 2021b; Hong et al., 2020; Huang, 2022; Li, 2022; Syakur, 2021; Vega et al., 2020; Yon et al., 2022). Motivation is an influential factor in the efficient completion of every action that we undertake, from waking up in the morning to sleeping at night. To maximize effectiveness while reading, the individual needs to be highly motivated to read. In this study, which was planned to provide a more motivating reading environment using digital games supported by RT, students achieved higher motivation scores. It is known that participation in collaborative learning situations causes students' motivation to participate in the process to increase (Schnake, 1991). It can also be said that learning/reading processes that offer RT-like collaboration opportunities will positively affect motivation. In addition, when an evaluation was made according to the sub dimensions of the scale used in the present research, it was seen that the students did not perceive reading as a challenging activity in the context of reading processes supported by collaborative activities, they strove for reading proficiency, they willingly showed continuous effort in reading, and reading was perceived as a social process. In this study, in parallel with the findings of some previous research (Muthik et al., 2022; Seaton et al., 2014; Zhenlong, 2021), with the inclusion of the RT strategy in the learning process, students both learned to read and had their motivation levels increased. Having a high level of anxiety can make a situation stressful or otherwise undesirable. For this reason, it may be possible for a student to reach the desired learning outcomes more effectively without any or with only minor anxiety. In this study, which was designed to provide a carefree reading environment with less anxiety using digital games supported by RT, it was discovered that the learners were less anxious. It has been reported that failure in collaborative tasks increased in an online environment as anxiety increased (Oliveira et al., 2011). To reduce anxiety in these environments, it is recommended to increase the communication between peers and teachers (Zembylas, 2008). This way, a safe learning environment can be created (Lawless & Allan, 2004). When the dimensions of the anxiety scale used in this study were examined, it was observed that the DG-RA group had less anxiety about planning the learning process, which included reading, comprehension, and analysis. In the literature, it has been reported by different researchers that the use of RT reduces anxiety, although not totally (Andewi et al., 2016; Palincsar & Brown, 1983). With the digital games developed here in line with the RT strategy, students read science

texts better. In summary, this study examined the effects of these digital games on reading comprehension, reading motivation, and reading anxiety for science texts by integrating a social constructivist RT approach into digital games. Although RT has been frequently preferred in reading processes in previous studies, its philosophical origins have not been discussed much, creating the feeling that this strategy is pursued with behavioral motives. RT should be applied based on the assumption that language is a sociocultural construct. Although it took a long time to plan this study, write the stories, and develop the games, it is promising that the research produced positive results. This approach also has the potential to develop into a guided study to overcome research limitations of the Turkish language in terms of the digitalization of RT. The present study also reflects how social constructivism can be emphasized in research and how collaboration can be integrated through different models in learning environments. Overall, the middle school students in the DG-RA group had higher reading comprehension and reading motivation scores and lower reading anxiety. I believe this research has produced findings that may guide the dissemination of digital game interventions supported by different social constructivist models, including RT or collaboration, and it shows the need for more research in this area. Social, collaborative, and simultaneous reading interventions offer all readers unique reading and learning environments. Furthermore, such settings are applicable for every individual with reading difficulties, and it is essential that they be tested by different researchers.

With this study, an opportunity was created for pandemic and similar compulsory distance education scenarios, for our special children studying at home or for learning processes independent of time and place. Moreover, with this opportunity, it was seen that collaboration is possible in distance education environments. Considering today's conditions and 21st century learners, we should be aware that the communication network is expanding. We should focus on the importance of such collaboration opportunities in order to use this communication network effectively.

5.1. Limitations

This study has a few notable limitations. First, there was no treatment concerning or even an estimate of the various systematic errors that may have occurred, which could potentially be much larger than obvious statistical errors. If one considers biases, this study did not, for example, test performance differences according to the demographic characteristics of the students, such as gender or age. However, it is understood that there are numerous other sources of non-statistical errors. Care was accordingly taken to create a homogeneous group of participants in the present study and group comparisons were carried out. Considering only statistical errors, it is evident that the study's sample size was small, which raises concerns about the representativeness of the sample and the generalizability of its findings (Larson-Hall, 2016). It may be possible to repeat the study with a larger sample size, whereby demographic characteristics could also be included in the analysis, as well as considering, evaluating, and possibly correcting various other non-bias systematic errors to achieve measurements with higher precision. Such a treatment was not essential at present, as the overall measurement error was already high due to limited statistics. Additionally, this study took a quantitative approach by focusing on reading scores. It could be ensured that the quantitative data support the students' qualitative views of the intervention, which would yield a more comprehensive understanding of the subject.

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