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Texts that become reality: An alternative solution for weak readers

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Abstract

In teaching reading, one of the basic skills of education, students may sometimes experience some difficulties in comprehending and remembering what they read. In recent years, electronic and augmented reality-supported books have been included in the literature as an alternative solution to these difficulties. This study examined the effect of augmented reality-supported books on reading comprehension and retelling of second-grade primary school students. A quasi-experimental design comparing control and experimental groups was used in the study. The study group consisted of 40 students with poor reading comprehension who were studying in the second grade of primary school. Reading comprehension questions and retelling rubric developed for two texts with augmented support were used as data collection tools. To analyze the data, the Mann-Whitney U, nonparametric, was used to compare the groups. As a result of the study, it was observed that the reading comprehension and retelling scores of the experimental group who read augmented reality-supported informative and narrative texts were higher than the reading comprehension and retelling scores of the control group who read printed texts. The results obtained are thought to contribute to the national literature, especially considering that the studies on the effects of AR-supported books in education are insufficient.

Keywords: Augmented reality, Reading comprehension, Retelling.

Introduction

In today's world, developing technology is effective in education, as in many areas of life, different educational technologies are integrated into learning environments. This integration is because digital-based learning allows students to access more information, and the content can be customized according to the student. One of the most important advantages of digital-based learning is that it allows students to work independently and on their courses.

Digital technology also enhances individuals' communication skills, creativity, and critical and systematic thinking skills, enabling them to discover faster and more effective ways of problem-solving (Radu et al., 2011). Therefore, discoveries for learning require planning new physical and virtual teaching spaces and introducing new digital resources to promote a more dynamic teaching-learning process (Dufva & Dufva, 2019; Rensink, 2020). One of these resources is augmented reality applications.

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Augmented reality

Augmented reality is a technology that does not complement the real world with virtual objects created by a computer simultaneously; in other words, it is a technology that combines real and virtual worlds (Sırakaya & Alsancak Sırakaya, 2018). Looking at the literature on the use of augmented reality (AR) in education, it is seen that the first studies date back to the early 2000s (Olsson & Salo, 2011; Van Krevelen & Poelman, 2010). Studies have explored the potential of using augmented reality-based applications in educational environments and the innovations they provide in learning-teaching activities (Wu et al., 2020); it is predicted that augmented reality-based applications will improve the education system (Cabero & Barroso, 2016; Villalustre, 2020; Garzón et al., 2020). It enables students to interact (ChanLin et al., 2019) and increases their motivation to learn (Barroso & Gallego, 2017; Beiro, 2014; Cózar-Gutiérrez et al., 2015; Harley et al, 2016; Villalustre, 2020) present information that is difficult to experience in the classroom, and allow experiencing events in daily life (Vichivanives & Ralangarm, 2015; Villota & Vásconez, 2020; Wu et al., 2013) make augmented reality applications attractive for educators (Figure 1).

Figure 1 Augmented reality application examples in education

Source: https://blog.quicksigorta.com/teknoloji/sanal-dunyanin-teknolojik-koprusu-artirilmis-gerceklik-1874, http://kurtogluebru.com/egitimde-arttirilmis-gerceklik-uygulamalari/, https://www.btgunlugu.com/zyxel-vmg3625-t50b-ile-hiziniza-hiz-katin/

Ironically, while our world has a three-dimensional structure, the shapes and objects in books are usually two-dimensional. As a solution, AR-based books provide us with three-dimensional data and make the subjects more understandable. According to the study by Mayer (2001), learning environments in which text and interactive visuals are used together provide more effective learning. In other words, the more students' senses are addressed, the more permanent the learning becomes. For this reason, AR-supported books encourage learning positively. To encourage reading habits in children today, interactive AR storybooks not only provide information but also entertainment. Sahey (2014) stated that since children prefer sound and graphics, an augmented reality storybook provides these and allows interaction so that children

can take part in the story and learn simultaneously.

Augmented reality books

In the early literacy period, the first stage of education, students may have difficulty recognizing new words. As a result, they cannot understand what they read. In order to ensure reading comprehension, which is the ultimate goal of reading, digital applications that are suitable for students' ability to analyze the text they read and structure it in their minds both attract students' attention and provide an effective educational environment.

However, the comparative examination of printed and digital books in terms of reading skills has been brought to the agenda; it has been found that reading from the screen remains superficial and cannot be understood (Chen & Chen, 2014), that it is more accurate and practical to read the information in printed form rather than digital books (Stanica et al, 2019), that digital books are considered unsuccessful by some publishers (Flood, 2018), and that most children prefer printed books to digital books (Ahmadi, Maktabifard, & Momeni, 2015; Strouse & Ganea, 2017). On the contrary to these findings, there are studies that digital texts increase reading comprehension (Kandemir & Bay, 2023; Şentürk Leylek, 2018), are interesting and fun (Duran & Alevli, 2019; Kircz, Kreutzer & Stoop, 2013; Yaman & Dağtaş, 2013).

Augmented reality books are an alternative initiative in this comparative analysis of printed and digital book use (Dünser & Hornecker, 2007). In augmented reality books, while the printed book remains the same, the multimedia content can be viewed through a digital device. In augmented reality books, digital content can be designed with audio, three-dimensional animation, or video and can be viewed with any digital device such as a tablet or smartphone.

Augmented reality books are expected to provide a comfortable reading experience (Grasset, Dünser, and Billinghurst, 2008), improve comprehension of complex content (Dünser & Hornecker, 2007b), help students with different reading abilities (Dünser, 2008), and improve early readers' reading comprehension.

Purpose of the research

Based on the experimental studies on the effect of augmented reality-supported applications in the educational process (Cabero-Almenara et al., 2019; Çetin & Türkan, 2022; Dimitriadou et al., 2020; Fidan & Tuncel, 2019; Huang et al., 2019; Karagözlü, 2018; Low et al., 2022; Redondo et al., 2020; Sarıkaya & Çakmak, 2018; Şahin & Yılmaz, 2019; Talan, Yilmaz, & Batdi, 2022; Yip et al., 2019), in addition to recent studies examining the effect of augmented reality on reading skill development (Anuardi et al., 2022; Bursalı & Yılmaz, 2019; Çetin & Ulusoy, 2023). Although research on the relationship between AR and reading skills has gained an important place in the literature, it is noteworthy that no studies are focusing on the effect of augmented reality-supported storybooks on the reading skills of students who have poor reading skills according to their grade level without any diagnosis of learning disabilities. The studies were mainly conducted for students with special needs (such as dyslexia, Autism Spectrum Disorder) (Dwijayanti & Sihombing, 2021; Lazo-Amado, Cueva-Ruiz, & Andrade Arenas, 2022). However, when the PISA 2022 report results are analyzed, it is seen that there is a significant decline in reading skills in OECD countries and Turkey (Ministry of National Education, 2022). Looking specifically at Turkey, although the gap between Turkey and the OECD average scores in mathematics, science, and reading skills continues to decrease, Turkey remains behind the OECD average (OECD, 2022).

When reading comprehension levels are examined, especially at the primary school level, the reading comprehension averages of 1st-4th grade students in our country are low or medium (Aytekin & Güleçol, 2024; Batmaz & Erdoğan, 2019; Kıran, 2019).

Considering the statistical data, it is necessary to focus on alternative solutions for developing reading comprehension, which is the basis of all disciplines. While working on these solutions, the most basic clue is the areas that attract children's attention and interest and that they spend the most time in during the day.

When we look at the activities in which today's children spend the most time, we see that they are keen on digital technology. As a matter of fact, in many studies examining children's digital technology use and screen time, it has been revealed that they spend a significant part of their days in front of the screen (Mustafaoğlu, Zirek, Yasacı, & Razak Özdinçler, 2018; Neumann, 2015; Tena, Gutiérrez, & Cejudo, 2019; Qi, Yan, & Yin, 2023). In a study conducted by the Turkish Statistical Institute on the use of information technologies by children aged 6-15, it was reported that the rate of internet use was 82.7%, the rate of cell phone/smartphone use was 64.4%, the rate of computer use was 55.6%, and the rate of tablet use was 57.2%. When the children who participated in the research were asked how the time they spend in front of the screen for activities such as using computers, mobile phones/smartphones, internet, and social media, playing digital games, and watching TV affected them, the highest percentage (35.9%) stated that they read fewer books because they spend more time in front of the screen (Turkish Statistical Institute, 2021). Considering the critical role of reading books in developing reading skills, it is important to turn this orientation of children towards digital technology into an advantageous situation and integrate reading into the digital platform.

Based on the effect of AR applications in education on the development of reading skills, this study aims to examine whether augmented reality-supported storybooks affect the reading of students with poor reading skills compared to printed storybooks. Because these children do not have a diagnosis, they cannot receive support for their development, and at the same time, they cannot show the reading and reading comprehension skills required by their age and grade level. Therefore, it is thought that examining the effect of augmented reality-supported storybooks on students' reading, which is the target of this study, will contribute to teachers improving the reading of weak students by using such books as materials in the classroom, and will be different from previous studies on reading AR books in terms of goals, measurements, and methodology. For this purpose, the study's problem statement was designed as “What is the effect of augmented reality-supported books on the reading comprehension and retelling skills of weak readers in the second grade of primary school?”. Sub-problems are;

1. Does the reading comprehension and retelling scores of the control and experimental groups in the informative text differ?
2. Does the reading comprehension and retelling scores of the control and experimental groups in the narrative text differ?

Method

This section includes information on research design, study group, data collection process, and data analysis.

Design

This study investigated the effect of AR-supported books on reading comprehension and retelling skills of 2nd-grade primary school students. This study used a quasi-experimental design with pretest-post-test control group as the research design (Frankel & Wallen, 1996). Paired groups were not randomly assigned; the experimental and control groups were randomly assigned.

Participants and procedure

The study group consisted of 40 students attending the second grade (7 years old) primary school in the city center of Konya. The students to participate in the study were determined according to the opinions of the teachers and the students' Turkish course report card evaluation. The study selected 100 students whose Turkish course report card evaluation 'needs improvement.'

Then, these students read 'The Sun is Asleep' in the Nature and the Universe theme in the second-grade Turkish textbook (Gündoğan Eski, Aktaş, & Erkal 2019). In selecting the text, care was taken to ensure that it was a text that the students had not encountered before. Each student's reading was audio-recorded, and then the reading accuracy, reading speed, and prosody scores, the components of reading, were calculated. In the literature, 96% and above scores represent the free reading level, scores between 90% and 95% represent the improvable reading level, and scores of 89% and below represent the reading level of concern (Vaughn & Linan-Thompson, 2004). Regarding reading speed, the range of words expected to be read per minute by second-grade primary school students was determined as fall (30-80), winter (50-120), and spring (70-130) (Rasinski, 2010). Since this study was conducted in winter, the relevant word range was taken as a basis. The prosody score represents the free reading level for scores between 13 and 16, the improvable reading level for scores between 9 and 12, and the reading level of concern for scores eight and below (Aşıkcan & Saban, 2021). Out of 100 students, 40 with a correct reading percentage of 89% and below, a reading rate of 50 words per minute, and a prosody score of 8 and below constituted the study group. Finally, the study group was divided into control group (20) and experimental group (20). The names of the students were coded with the letter (s). Data on the study group are given in Table 1.

Tables, figures, pictures, graphics, and similar aspects should be embedded in the text and not provided as appendices. Please locate tables as editable text and not images; however, figures might be presented in different forms, such as images. Please use Amasis MT Pro, font size 12 for tables and figures. While generating tables, ensure that the indentation under the paragraph tab is as follows: before and after: 0, single spacing. Tables and figures should be left aligned, and the text wrapping feature should be turned off.

Table 1 Information about the Study Group

Control Group	Reading Accuracy (%)	Reading Speed (sec)	Prosody	Experimental Group	Reading Accuracy (%)	Reading Speed (sec)	Prosody
S1	79.44	45	4	S21	78.74	28	4
S2	81.18	28	6	S22	88.50	42	7
S3	83.62	46	7	S23	81.88	40	4
S4	83.62	46	7	S24	86.06	33	4
S5	84.32	48	5	S25	85.01	33	4
S6	86.75	38	5	S26	86.41	35	4
S7	87.80	21	4	S27	76.65	29	4
S8	77.35	6	4	S28	89.19	49	8

S9	86.41	23	5	S29	79.09	14	4
S10	84.66	24	7	S30	83.62	44	7
S11	85.71	38	7	S31	82.92	36	8
S12	88.85	42	8	S32	83.27	33	8
S13	86.06	36	8	S33	82.52	33	5
S14	85.36	34	7	S34	88.15	23	4
S15	82.57	27	4	S35	80.83	41	4
S16	81.53	36	7	S36	78.74	37	4
S17	88.50	36	8	S37	86.06	39	6
S18	83.97	46	7	S38	88.15	25	4
S19	88.15	45	8	S39	78.74	18	4
S20	79.44	37	5	S40	87.80	41	5

Measures

Augmented reality books

The books published by GAGA Publications, 'AKUT Taught Me This' in the informative genre and 'A Child is a Miracle' in the narrative genre, were used in the study. These books were preferred because they are the only books with augmented reality supported published in Turkish for the 7-9 age group. The book's augmented reality-supported version can be accessed through the publisher's mobile application. English and Russian language options are available for both books. The books can be accessed without fee or subscription once the application is downloaded to a tablet or mobile phone. Images of the books and the introduction of the book 'One Child One Miracle' are below (Figure 2 – 3 – 4 – 5 – QR code).

Figure 2

Figure 3

Figure 4

Figure 5

QR code

Reading comprehension questions

Since the best way to measure the comprehension of texts is to ask questions about the text content (Güneş, 2009), the researcher prepared a total of 20 reading comprehension questions, 10 questions (in-text: 5 questions, out-of-text: 5 questions) in each of the books 'AKUT taught me this' and 'A Child is a Miracle.' Akyol (1997) made a classification of the answer sources of questions. According to this classification, questions have answers within, outside, and between texts. Questions with an answer in the text aim to establish in-text meaning. These are questions whose answer is in the text but is not given directly, is implied, and requires the reader to use his/her prior knowledge and experience to find the answer. These questions aim to construct meaning outside the text. For example, for the text 'AKUT Taught Me This,' the in-text question 'What was fascinating for Arel and Lara?' was asked; for the text 'A Child is a Miracle,' the question 'How does Maya spend her time at home?. Students' responses to the reading comprehension questions were scored using the Inaccurate Analysis Inventory developed by Ekwall and Shanker (1988) and adapted into Turkish by Akyol (2016). At the end of the evaluation, a total score for reading comprehension skills is created for each student individually.

Retelling rubric

A 'Retelling Rubric' was developed to examine the effect of AR-supported story reading on second-grade students' retelling. In creating the rubric, the stages developed by Andrade (1997) were considered. (Figure 6).

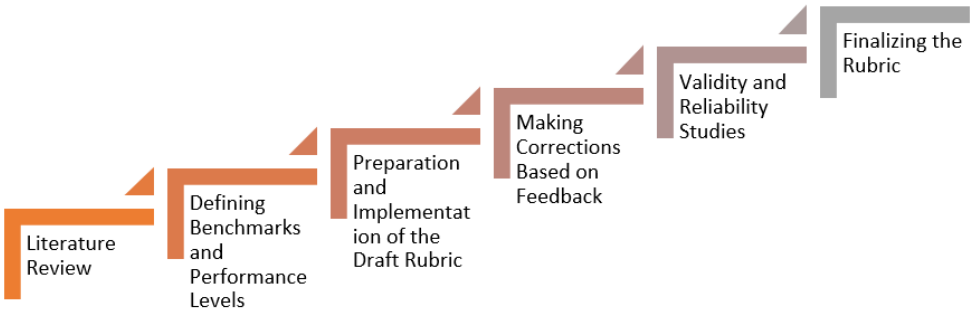

Figure 6 Rubric development stages

As seen in Figure 7, in the first stage, the elements of story retelling were identified through a literature review. The elements of retelling were determined as 'characters, details about the story, problem situation, solution of the problem situation in the story, retelling the events in order, main idea.' Four performance levels were determined for the rubric as 'Poor (1), Average (2), Good (3), Advanced (4)'. The lowest score that a student can get from the retelling rubric is 6, and the highest score is 24. After the rubric was created, it was presented to the opinions of 7 faculty members who are experts in the field of primary literacy and Turkish language teaching working in the department of classroom teaching. The rubric was finalized in line with the expert opinions.

Procedures

After the ethics committee permissions were obtained, face-to-face interviews were held with the administration of the implementation school and the second-grade teachers where the

implementation would take place. After being informed about the process, the implementation process was planned based on volunteerism. First of all, students whose Turkish course report card evaluation 'should be improved' were identified with the guidance of classroom teachers. Then, 40 students, who were the study group of the research, were determined by reading texts to these students. After the study group was determined, the researcher created a study schedule and decided to implement the study with four students per day. Since education in public primary schools in Turkey is divided into morning and afternoon groups, the planning was made by considering the students' course schedules and public holidays during the hours when the second graders were at school. The implementation lasted 6 weeks. Information about the process is given in Figure 7.

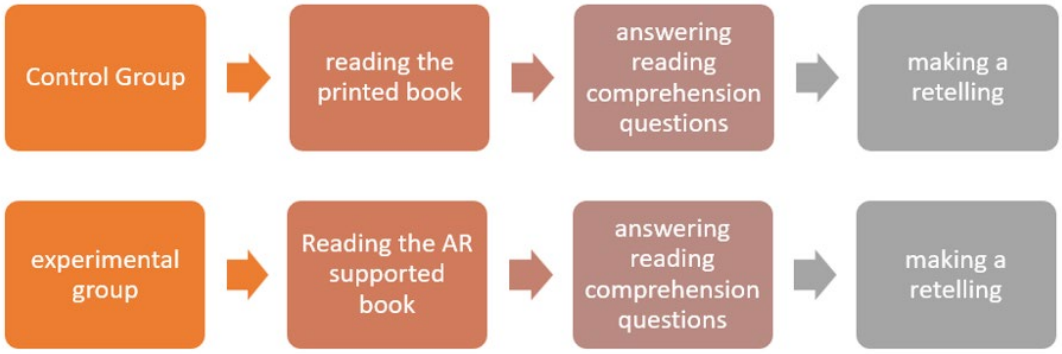

Figure 7 Control and Experimental Groups Implementation Process

During the implementation process, a room was allocated by the school administration, and the study was carried out there. Each student was informed before reading. No intervention was made during their reading, and all distracting factors were tried to be isolated. The students voluntarily recorded the answers to the reading comprehension questions and the retellings with a voice recorder. Sample visuals of the implementation of the control (Figures 8 - 9) and experimental group (Figures 10 -11) are given below.

Figure 8

Figure 9

Figure 10

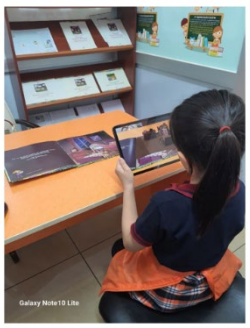

Figure 11

Data analysis

The content validity index was obtained from expert opinions for the questionnaire items. Two different raters scored the narrative and informative texts, and the kappa agreement index was used to measure the reliability of the two raters. The Mann-Whitney U, nonparametric, was used to compare the scores of the students' informative and narrative texts between the control and experimental groups. This nonparametric method was used when the data in the control and experimental groups was large enough (N>30). In significant cases, the effect size showing the magnitude of the difference was obtained. The effect size used in the Mann-Whitney U analysis

method is the r value determined by Cohen and calculated by Z/square root (N). If the obtained effect size r value is 0.10-0.30, there is a small effect; if 0.30-0.50, there is a moderate effect; and if it is more significant than 0.50, there is a high effect (Cohen, 1988). p<.05 significance level was examined in statistical comparison.

Validity, reliability, and ethical considerations

Content validity index

The reading comprehension and retelling questionnaires were sent to 7 experts, and three categories were created for the items in these questionnaires: “appropriate,” “should be corrected,” and “not appropriate.” Content validity ratio (CVR) and content validity index (CVI) were calculated for the data obtained from the expert opinions, and the calculations made in this context were made using the Microsoft Excel program (Table 2-3-4). Nu is the frequency of the number of experts who indicated the item as appropriate, and N is the total number of experts. CVR is an item index for the inclusion or exclusion of items in the measurement tool, and Lewishe (1975) stated that CVR is calculated using the following formula:

$$CVR = \frac{N_u}{\frac{N}{2}} - 1$$

For the items that should be removed from the measurement tool according to the CVR values, the critical value at the 0.05 significance level should be considered. Ayra and Scally (2014) stated that the minimum CVR criterion required for seven experts is 1, and items with a CVR below this value should be removed. Content validity is significant if the CVI value is greater than or equal to the CRV value.

Table 2 CVR and CVI Values for Informative Text

Informative Text	Appropriate	Should be corrected	Not appropriate	CVR	CVI
Question 1	7			1**	
Question 2	7			1**	
Question 3	7			1**	
Question 4	7			1**	
Question 5	7			1**	
Question 6	7			1**	1**
Question 7	7			1**	
Question 8	7			1**	
Question 9	7			1**	
Question 10	7			1**	

Among the 10 items in the informative text, seven experts indicated them as appropriate. Therefore, the CVR value is one, and all these values equal the CVI criterion. All items were included in the informative text.

Table 3 CVR and CVI Values for Narrative Text

Narrative Text	Appropriate	Should be corrected	Not appropriate	CVR	CVI
Question 1	7			1**	
Question 2	7			1**	
Question 3	7			1**	
Question 4	7			1**	
Question 5	7			1**	
Question 6	7			1**	1**
Question 7	7			1**	
Question 8	7			1**	

Question 9	7	1**
Question 10	7	1**

Among the 10 items in the narrative text, seven experts indicated them as appropriate. Therefore, the CVR value is one, and all these values equal the CVI criterion. All items were included in the narrative text. Seven experts stated it as appropriate among the six items in the text related to retelling. Therefore, the CVR value is one, and all these values equal the CVI criterion. All items were included in the retelling text.

Table 4 Inter-rater Reliability Table

Text	Score	Kaa	p
Informative Text	in-text	0.94	0
	off-text	0.92	0
	Reading Comprehension Total	0.97	0
	Retelling	0.96	0
Narrative Text	in-text	0.91	0
	off-text	0.95	0
	Reading Comprehension Total	0.96	0
	Retelling	0.98	0

Cohen kappa value is a coefficient showing agreement between two raters (Cohen, 1960). When the Cohen kappa value is 0.80 and above, the agreement between the raters is very high. Accordingly, the agreement for the inter-rater agreement coefficients obtained for reading comprehension and retelling in both texts is high. The reliability of the reading comprehension and retelling instruments was obtained with Cronbach's alpha coefficient, as shown in Table 5.

Table 5 Reliability Table

	Alpha	Number of items
in-text	.701	5
off-text	.706	5
Reading Comprehension Total	.747	10
Retelling	.954	6

The reliability for reading comprehension was 0.747, 0.701 for the in-text sub-factor, and 0.706 for the out-of-text sub-factor. For retelling, the reliability coefficient was 0.954. Pallant (2017) stated that when the reliability coefficient is 0.70 and above, the reliability of the measurement results is high. As a result, reliability is high for all questionnaires.

Research and publication ethics

All rules specified in the "Directive on Scientific Research and Publication Ethics of Higher Education Institutions" were followed in this study. None of the actions specified under the second section of the Directive, "Actions Contrary to Scientific Research and Publication Ethics," have been carried out.

Ethics committee permission

Board name= Selçuk University Faculty of Education Ethics Committee
Date of decision= 16/11/2023
Document number number= E.639001

Findings

Findings about informative text

In the first sub-problem of the study, the reading comprehension and retelling scores of the

control and experimental groups in the informative text were analyzed comparatively. The findings are given in Table 6 and Figure 12.

Table 6 Comparison of control and experimental groups' reading comprehension and retelling scores of the informational text

Informative Text	Group	N	Mean	ss	Mean rank	Z	p	r
in-text	Experimental	20	7.10	1.52	28.45	-4.354	.000	0.69
	Control	20	4.30	1.92	12.55			
out of text	Experimental	20	10.85	2.35	29.30	-4.790	.000	0.76
	Control	20	5.40	2.28	11.70			
Reading Comprehension Total	Experimental	20	17.95	2.68	30.23	-5.285	.000	0.84
	Control	20	9.70	2.62	10.78			
Retelling	Experimental	20	19.80	3.33	30.10	-5.218	.000	0.83
	Control	20	10.50	3.46	10.90			

Z: Standard values of Mann-Whitney U Test statistic

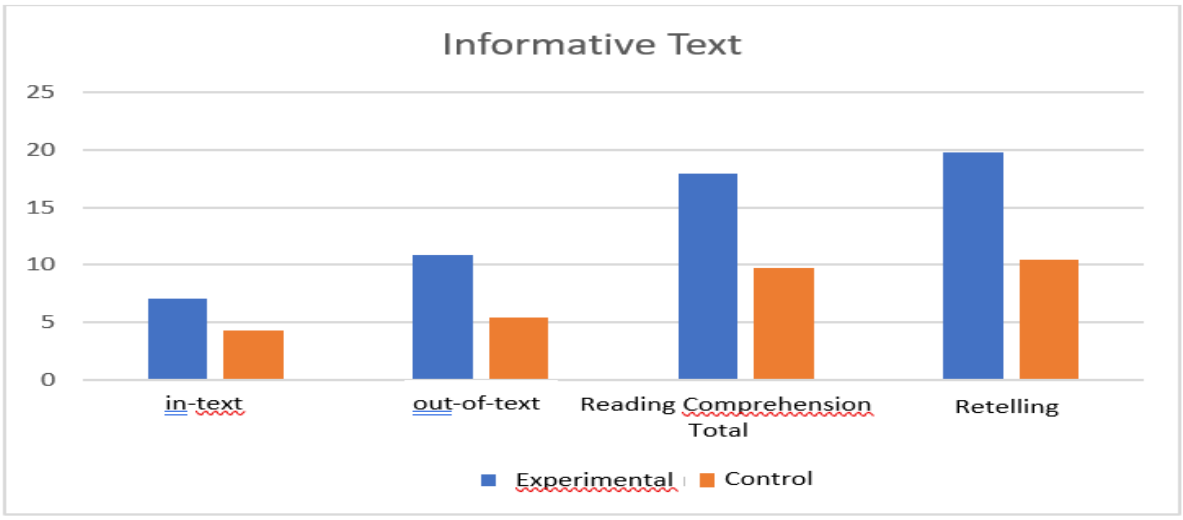

Figure 12 Graph of reading comprehension and retelling scores in experimental and control groups for informative texts

The control and experimental groups' informational reading comprehension and retelling scores were compared using the nonparametric Mann-Whitney U test analysis method. Significant differences were found between the informational in-text (Z=-4.354, p<.05), out-of-text (Z=-4.354, p<.05), and reading comprehension (Z=-5.285, p<.05) scores of the children in the experimental and control groups. In addition, a significant difference was found between the retelling scores of the children in the experimental and control groups in informational text (Z=-5.218, p<.05). The effect size for all significant differences was between 0.69-0.84, and a large effect was obtained. The mean scores of the children in the experimental group were higher than those in the control group regarding reading comprehension in the informative text, in-text, out-of-text, and general reading comprehension scores. In addition, the mean ranks of the children in the experimental group's retelling scores in informative text were higher than the control group.

Findings about narrative text

In the first sub-problem of the study, the reading comprehension and retelling scores of the control and experimental groups in the narrative text were analyzed comparatively. The findings are given in Table 7 and Figure 13.

Table 7 Comparison of control and experimental groups' reading comprehension and retelling scores of the narrative text

Narrative Text	Group	N	Mean	Ss	rank means	Z	p	r
in-text	Experimental	20	7,9	1,92	29,43	-4,86	.000	0,77
	Control	20	3,4	1,85	11,58			
out of text	Experimental	20	13,25	1,83	29,98	-5,162	.000	0,82
	Control	20	5,4	3,17	11,03			
Reading Comprehension Total	Experimental	20	21,15	2,89	30,28	-5,3	.000	0,84
	Control	20	8,8	3,91	10,73			
Retelling	Experimental	20	20,55	2,06	30,1	-5,21	.000	0,82
	Control	20	11,6	3,28	10,9			

Z: Standard values of Mann-Whitney U Test statistic

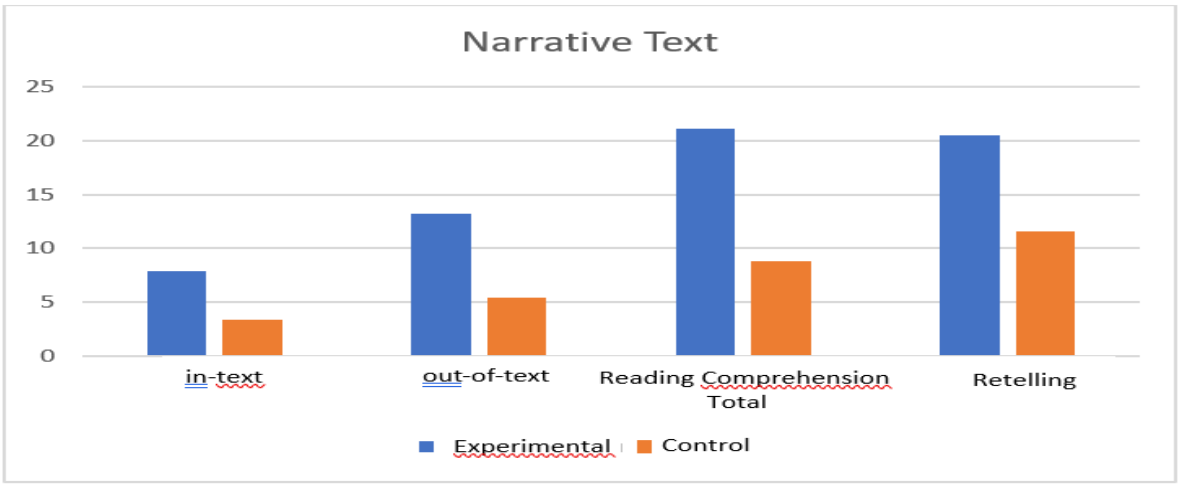

Figure 13 Graph of reading comprehension and retelling scores in experimental and control groups for narrative text

The experimental and control groups ' reading comprehension and retelling scores were compared using the nonparametric Mann-Whitney U test analysis method. A significant difference was found between the in-text (Z=-4.86, p<.05), out-of-text (Z=-5.162, p<.05), and reading comprehension (Z=-5.3, p<.05) scores of the children in the experimental and control groups. In addition, a significant difference was found between the retelling scores of the children in the experimental and control groups in the narrative text (Z=-5.21, p<.05). The effect size for all significant differences was between 0.77-0.84, and a large effect was obtained. The mean ranks of the children in the experimental group's in-text, out-of-text, and general reading comprehension scores were higher than the control group. In addition, the mean scores of the children in the experimental group for retelling in narrative text were higher than those of the control group.

Conclusion and discussion

The study examines the effect of reading books with augmented reality support on reading comprehension and retelling of second-grade students with poor reading skills. As a result of the research, the reading comprehension and retelling scores of the experimental group reading from augmented reality-supported books were higher than those of the control group reading from printed books.

When the reading comprehension scores of both groups were examined, the reading comprehension scores of the experimental group differed significantly, especially in questions

that do not have a direct answer in the text and require inference from the text, which are defined as non-text questions. Similar results were obtained in some studies (Bursalı & Yılmaz, 2019; Çetin, 2020; Çetinkaya Özdemir & Akyol, 2021; Ebadi & Ashrafabadi, 2022; Şahin & Yılmaz, 2019; Şimşek, 2024; Şimşek et al., 2024) examining the effects of augmented reality supported books on reading comprehension in the literature.

Likewise, it was observed that there was a differentiation in favor of the group that read the book with AR support in the retellings made by both groups for remembering the read texts. While the students in the control group were generally able to remember either the introduction or conclusion sections of the texts during their retellings, the experimental group students who read the texts in the AR-supported form were able to remember and explain the details of the texts more efficiently. Studies in the literature examine the relationship between AR-supported books and reading recall and obtaining similar results (Çetin, 2020; Liu et al., 2024; Stearns, 2012; Şimşek, 2024).

The three-dimensional visuals of the characters in the augmented reality-supported books, the support of the stories with external sounds (such as animal sounds and wind sounds) in the plot, and the audio narration of the text enable the student to visualize what he/she reads in his/her mind during reading and to understand it easily. Indeed, evidence that combining text and pictures is beneficial for memory has been widely described in the literature (Bernard, 1990; Glenberg & Langston, 1992; Reed &Beveridge, 1986, 1990). In this regard, Chen (2006) argues that printed methods impose various limitations in helping students to recall information. Therefore, it can be said that texts presented with AR technology increase recall.

AR-supported books offer a more active reading experience by drawing students into the story. Students can better focus, understand, and remember what they read by interacting with the text. In addition, the experiences offered with AR can help readers become more emotionally connected to the text. It can be said that this connection strengthens comprehension.

On the other hand, during the implementation of the study, there were some problems, such as not opening the AR application on time due to the network connection and stuttering in the movement of the images in the AR mobile application of the books. The literature also mentions technical problems, such as difficulties in detecting the user's position in indoor spaces (Palmarini et al., 2018) and limitations in pattern recognition affecting ergonomics applications (Fraga-Lamas et al., 2018). In the study, students were sometimes distracted because they were curious about the AR mobile application and had not encountered it before, or they experienced difficulties using it because they did not know how to use it. Studies on the difficulty of using AR-supported books (Akçayır et al., 2016) show that the difficulties experienced in this study are at an encounterable level. Teachers' resistance to the use of AR-supported applications in the classroom (Lee, 2012) and the need for more information about the use of AR mobile applications (Akçayır & Akçayır, 2017; Turan et al., 2018) may be an inhibiting factor in the widespread use of this technology.

Despite the challenges, this study and several other studies in the literature provide evidence that augmented reality books support the comprehension performance of students with reading weaknesses. Combining information through multiple channels spanning auditory and visual modalities contributed to more effective learning and better retention than processing information through a single channel (Bus et al., 2014). Thus, multimedia content can be said to

reduce cognitive load and increase story comprehensibility (Kao et al., 2016).

Limitations

This study has several limitations. First, the participants were children with poor reading skills attending the second grade of primary school. Therefore, the results are limited to this age range. However, future studies can be conducted with poor readers at different grade levels during primary school to interpret better the effects on children's reading comprehension and retelling performance.

Statement of researchers

Conflict statement

The author declares that they have no conflicts of interest. The publication rights of this article have been transferred to the Pedagogical Perspective Journal.

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