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Students' Comprehensions Ability on a Digital Storybook: a Quasi Experiment Research with Fry Readability Analysis

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Abstract

This study aims to determine the effectiveness of Fry readability-based digital storybooks on reading comprehension skills among elementary school students. The method used in this study was an experimental research design with a pretest-posttest control group design to measure students' reading comprehension skills. The sample of this study was fourth-grade elementary school students. Data were collected through reading comprehension skills test sheets and analyzed using descriptive and statistical analysis to assess the extent to which the variables being studied align with the predetermined benchmarks. The results showed that digital storybooks based on Fry's graph readability are effective in improving the reading comprehension skills of fourth-grade elementary school students as evidenced by the n-gain test results, where the experimental class (medium) had higher scores than the control class (low). Based on the t-test, it has a significant effect with a calculated t-value greater than the table t-value. These findings show that books designed according to the grade level of students have an impact on reading comprehension

skills, and the integration of digital technology in book development can attract students' attention to read with full understanding.

Keywords: Storybooks; digital; readability; Fry; reading comprehension ability

Introduction

Reading comprehension is an important skill, as the process of reading and thoroughly understanding texts is a complex and interactive activity (Yurko & Protsenko, 2020). This ability requires various brain functions to work synergistically and often involves understanding context and layered meanings. Reading is one way to acquire knowledge and is fundamental to self-development (Marginson, 2023). According to Farrell, reading requires active interaction between the reader and the text (Braten et al., 2020). Reading can also be defined as a meaningful interpretation of written or printed verbal symbols, with the ultimate goal being understanding (Duke & Cartwright, 2021). The ability to understand text is directly related to the ability to construct meaning based on written signs (Shin, Cimasko & Yi, 2020). This process involves various factors related to the reader, the text, and the context. Skilled readers can coordinate word recognition and language comprehension while reading (Stanovich, 2024). This coordination includes the development of various skills related to reading. On the one hand, the ability to understand language is required, as well as prior knowledge, vocabulary, language structure, verbal reasoning, and strategically developed literary knowledge. Reading ability involves word recognition, such as phonological awareness, coding, and visual recognition (Olson et al., 2021). The combination of these two aspects results in effectiveness in reading.

Reading also involves recognizing visual forms, connecting shapes and sounds, and interpreting meaning based on experience (Commodari et al., 2020). A combination of language knowledge, cognitive style, and reading experience influences reading comprehension (Yapp et al., 2023). Mastering reading comprehension is essential for students because this understanding consists of many interrelated skills. Students need to master understanding to comprehend the material deeply. Many pieces of evidence show that reading ability has a direct impact on the overall learning process of students (Moats, 2020). When combining various reading skills, students interact with texts and internalize content from various academic fields. Therefore, reading comprehension becomes a critical factor in academic success.

Elementary school students are more enthusiastic about reading books with pictures and attractive illustrations (Hendratno et al., 2022; Istiq'faroh et al., 2020; Swaggerty, 2015). According to (Anantrasirichai, & Bull, 2022), The developed storybook contains more exciting images or animations (Anantrasirichai, & Bull, 2022). The developed books utilize the growth of digital technology to make more effective instructional materials (McKnight et al., 2016). Technology integration into education can develop more engaging and effective learning materials for elementary school students. Digital technology in developing books creates dynamic content based on students' understanding levels and integrates visual elements that can clarify and reinforce the message (Kim et al., 2018).

The Indonesian students' reading skill is considered low in elementary school (Khaerawati, Nurhasanah & Oktaviyanti, 2021; Dewani et al., 2024). They found difficulties in understanding the text that made it difficult to get and deliver the information in the reading text (Cahyani, Rahmawati & Torre, 2022). In addition, PISA (Programme for International Student Assessment) reported that the literacy rank of Indonesian students reading literacy is below the average among other nations (OECD, 2019). This can affect students' understanding of important information, including disaster mitigation materials. Therefore, it is necessary to improve students' reading skills so that they can be more effective in getting and understanding disaster mitigation information.

The level of readability greatly influences the experience in reading and understanding narrative texts (Gopal & Singh, 2020). Text that is easy to read and understand will connect readers

to the storyline and its characters (Boyd, Blackburn, & Pennebaker, 2020). A high level of readability improves the reading experience by providing readers with the opportunity to better comprehend the story's particulars and how it proceeds from different points of view (Barness & Papaelias et al., 2021). Moreover, good readability also plays a vital role in how readers understand the structure of the narrative, contradictions, themes, and messages conveyed by the text (Urfali & Ungan, 2023). Therefore, good reading enables students to grasp and value the incredible beauty and complexity of the story. Students are choosing books with the appropriate readability in the classroom can increase student enjoyment of reading and comprehension as well as learning efficacy (Dirgantari & Susantiningdyah, 2020).

Text readability needs to be a primary concern in material selection, especially for teaching materials and textbooks (Mohaiden, Ismail, & Ab Rashid, 2020). Teachers need to understand the readability level of textbooks before using them as learning resources for students. Teachers can evaluate the material's suitability for students' abilities by understanding its readability level (Jin et al., 2020). Teachers can select, refine, or adjust the text to make the material more suitable and engaging for students. The Fry graph is a method for assessing textbook readability (Abu & Khataybeh, 2020). This graph's readability formula considers two factors: word length and difficulty, measured by the syllable count of each word in the text. The Fry Graph Formula assesses text readability based on word difficulty and grammatical complexity. Tunde-Awe, 2023. The calculation method mirrors the previous formula; results on word difficulty and grammatical complexity are then compared with the Fry graph. The accuracy of using the Fry graph to measure text readability relies heavily on the precise counting of syllables, words, and sentences.

Several studies that have investigated students reading comprehension. Prabowo et al (2023) discovered that Indonesian and Malaysian students with varying degrees of reading literacy had distinct comprehension levels. Sofologi et al (2022) demonstrated that instrumental music training improved cognitive evaluation and reading comprehension to help students. Instead, Al-Janaideh et al (2022) suggest the Simple View of Reading for bilingual students to improve Arabic and English reading comprehension. Meanwhile, Rodriguez-Barrios et al (2021) used a Bayesian approach to analyze reading comprehension in Mexico, the results of which showed that teachers could modify lesson plans to improve student comprehension. Research by Vega Stanfield Mitra (2020) shows that elementary school students in urban areas with internet access are able to read complex texts with minimal teacher intervention. The results of the study by Roth Valenzuela Orellana (2020) revealed that the majority of students have a positive perception of the use of digital platforms, which helps students improve their reading comprehension skills. Lastly, Gentilini (2020) found that students with higher levels of education demonstrated better performance in reading fluency and comprehension.

Fry readability-based digital storybooks are used in this study to evaluate students' reading comprehension skills. The digital books are developed to help students improve their reading skills in a fun and attractively. Reading and understanding what you read is very important for learning in primary school. Kartika et al (2023) and Zhu and Zhang (2017) stated the same thing. Compelling reading enables students to access and understand information (Banditvilai, 2020). Knowledge obtained from reading must be understood deeply so that students can apply that information (Greenleaf et al., 2023). Good reading skills enable students to understand the mechanisms of disasters and the importance of preserving the environment as a preventive measure.

The Fry graph-based digital books in elementary schools have not been researched widely. Figure 1 provides Scopus data through Vosviewer bibliometric findings for "digital AND storybook" keywords from 2019 to 2024. Figure 1 shows several important features, highlighting frequently occurring and larger-sized terms like "teacher," "participant," "motivation," and "approach," suggesting a strong connection among the words in the research data. Keywords that are infrequently seen on VosViewer are shown in dim colour. Terms like "influence," "word," and "role" are infrequently encountered. The concepts of "elementary," "school," and "reading" have

not yet appeared. This suggests that the keyword should be further studied.

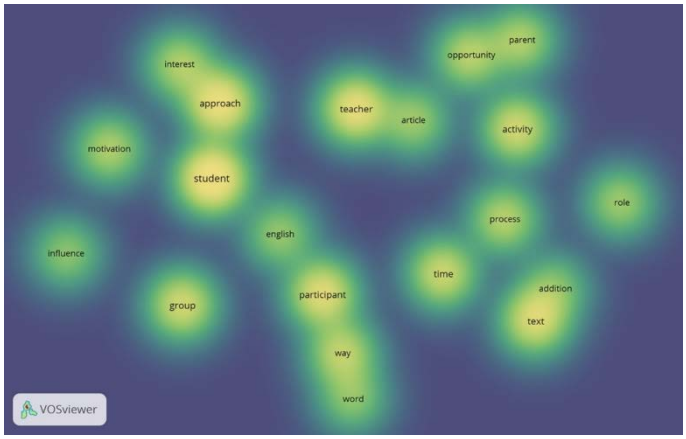

Figure 1. VosViewer visualization on the topic of digital storybook learning

The novelty of this research lies in measuring the influence of digital storybooks, whose reading texts have been assessed using the Fry graph, on reading comprehension skills. Therefore, this study aims to test the effectiveness of Fry graph-based digital storybooks in improving reading comprehension skills. Through an interactive and adaptive approach, the Fry-based digital graphic storybook is expected to address the challenges in reading comprehension skills for elementary school students.

Literature review

Reading comprehension

Reading comprehension is the process through which readers construct new meaning from written texts based on their prior knowledge, with the aim of developing new understanding and applying it in life (Sua, 2021; Mohseni & Ahmadi, 2017). Reading comprehension also enables individuals to effectively participate in society and develop skills and strategies throughout their lives (Smith, Snow, Serry & Hammond, 2021). If students have strong reading comprehension, they can flexibly use various strategies in different fields and aspects of everyday life. Conversely, if their reading comprehension is poor, they will struggle to be critical, reflective, independent, creative, and responsible in acquiring new knowledge.

In education, reading comprehension is directly related to learning achievement, allowing students to interpret, organize, and evaluate the information they read (Elleman & Oslund, 2019; Kim et al., 2021). Reading comprehension consists of two components: word recognition and language comprehension. Vocabulary knowledge is crucial as it connects phonology, orthography, and word meanings (Wegener et al., 2022). Research shows that an adequate level of word recognition fluency is necessary for advanced comprehension, as efficient word recognition paves the way for understanding more complex texts (Ghorbani et al., 2019).

Text comprehension improves with the number of known words in the text (Brysbaert, 2019). Reading comprehension plays a key role in students' learning and development (Soto et al., 2019). This ability not only affects academic achievement but also contributes to the development of cognitive skills, creativity, and critical and reflective attitudes. Therefore, improving word recognition and vocabulary efficiency lays the foundation for understanding more complex texts, ultimately supporting lifelong learning.

Digital storybook

Digital storybooks open up new opportunities for students to engage with technology (Bus, Roskos & Burstein, 2020). The use of digital technology among elementary school students has increased sharply in recent years (Haleem et al., 2022). The impact of the pandemic has significantly heightened the need for digital books (Panday & Pal, 2020). Digital storybooks offer opportunities to improve children's language skills, ultimately supporting their success in school. Meta-analytic findings show that well-designed digital storybooks can result in comprehension and vocabulary gains equal to or greater than those from reading print books for children aged 3 and older, both at home and in preschool (Reich et al., 2016). Other research also found positive effects from reading digital storybooks on children's comprehension from preschool to fifth grade, despite varying reading methods and conditions (Zucker et al., 2009; Savva, Higgins & Beckmann, 2022). A meta-analysis of elementary school students showed that digital storybooks improve receptive and expressive vocabulary as well as retelling abilities compared to traditional daycare activities or reading print books (Liu et al., 2024).

The positive impact of digital storybooks is associated with visual and audio elements that align with the story, as well as interactive and multimedia features that support the storyline. Digital storybooks provide synchronized audio narration and visual input, facilitating the integration of audiovisual information and enhancing story comprehension compared to reading print books (Cordes et al., 2020; Takacs, Swart & Bus, 2015). Additionally, animations in digital storybooks have been shown to improve children's comprehension compared to static images (Sarı et al., 2019). Other studies have found that multimedia elements such as animations, music, and sound in digital storybooks can improve children's story comprehension and vocabulary compared to orally narrated stories with static illustrations (Takacs et al., 2015). Thus, digital storybooks present significant opportunities to support children's language development and comprehension, particularly through audiovisual integration and interactive elements. This technology not only expands access to reading materials but also enhances children's engagement and story comprehension compared to print media. Well-designed multimedia elements can strengthen children's language skills, contributing positively to their cognitive development and school success.

Fry readability

The alignment between students' reading abilities and text readability is crucial for effective usage. Readability is defined as the level of difficulty of a book or text measured objectively, particularly based on its linguistic structure (Brewer, 2019). As the grade level increases, the complexity of the texts that need to be read also increases (Denton et al., 2015). Wang (2017) emphasizes that even if the reading theme is the same, differences in presentation and complexity will result in variations in readability. This indicates that the ideal readability differs at each grade level. Several studies have found that an author's writing style significantly influences readability (Çetġnkaya et al., 2018; Türkben, 2019). Authors can enhance readability by choosing concrete words, avoiding clichés, using short sentences, and prioritizing active verbs.

Readability can be used to assess students' comprehension of texts by analyzing word length, sentence length, sentence structure, and idea organization (Crossley, Skalicky & Dascalu, 2019). The selection of reading texts in textbooks is a major factor in developing students' language skills, with readability analysis employed to ensure that the texts match students' abilities. The Fry Graph is a method for measuring text readability using two main variables: the number of syllables and sentence length (Sudiati, 2023). Developed by Edward Fry in 1968, this graph helps determine

the difficulty level of a text and its suitability for specific reading levels (Gutierrez, 2014). To use this graph, users count the number of syllables and sentences in a sample text of 100 words, then plot the results on a graph with a vertical axis for the number of syllables and a horizontal axis for sentence length. The intersection of these two values indicates the appropriate grade level, assisting writers or educators in selecting texts that match students' reading abilities. Thus, the Fry Graph is an effective tool for assessing text readability, enabling educators and authors to determine the suitability of reading materials based on students' capabilities.

Research method

Research design

This study used quantitative research design with quasi-experimental research (Creswell, 2014). This research was conducted systematically and thoroughly by controlling certain conditions. In the experimental group, the treatment consisted of a Fry-based digital storybook, while the control group was given image media. This aims to determine the differences in the comparative results of both classes.

Population and sample

The population in this study was fourth-grade students at SDN Bligo, Candi District, Sidoarjo. The sampling technique used is purposive sampling. This technique was chosen because the researcher wanted to compare two classes, namely the control class and the experimental class. Both classes have similar characteristics, are taught by the same teacher, and follow the lessons at almost the same time with relatively equal academic achievements. The sample were 22 students from class IVA, in the experimental class, with 12 female students and ten male students. Students from class IVB, which totals 22 students, serve as the control class, with 13 female students and nine male students.

Data collection instruments and validation

The data were collected using tests and questionnaires. The tests used are pretest and posttest on reading comprehension skills, while the questionnaire is used to measure environmental concerns. The reading comprehension test questions number 10 that are measured. Before being used to measure reading comprehension ability, the test instruments and questionnaires need to undergo a trial to test their validity and reliability (Cohen & Swerdlik, 2018). The validity of the test instruments is conducted using the product-moment correlation, while the reliability of the test instruments is conducted using Cronbach's alpha formula (Field, 2017). The following reading comprehension ability instrument consists of reading comprehension levels, drawing conclusions, text structure, vocabulary usage, and evaluation (Dagostino, et al., 2014; Rahayu, et al., 2024).

The trial of the research instrument was conducted before analyzing the research data. At this stage, the validity test used the *Pearson correlation formula*. The reading comprehension test indicator had 10 instrument items. The instrument was categorized as valid if $r_{observed}$ is greater than r_{table}. The total number of students N = 24 with a significance level of 5% is 0.404. The following are the results of the student's reading comprehension validity test.

Table 1 presents that all of the students' reading comprehension ability test items showed $r_{observed}$ value > r_{table}, so it can be said that all of the students' reading comprehension ability test items are in the valid category and can be used as data collection instruments.

Table 1. Results of the validity test of the reading comprehension ability test

Item	Robserved	Rtable	Category
Item 1	0.465	0.404	Valid

Item 2	0.506	0.404	Valid
Item 3	0, 487	0.404	Valid
Item 4	0.456	0.404	Valid
Item 5	0.695	0.404	Valid
Item 6	0.521	0.404	Valid
Item 7	0.589	0.404	Valid
Item 8	0.591	0.404	Valid
Item 9	0.618	0.404	Valid
Item 10	0.581	0.404	Valid

After the validity test was conducted, the next step was for the researcher to conduct a reliability test. This is to find out whether the test instrument is reliable or not. The reliability results are stated as follows.

Table 2 presents that the results of the reliability test of the reading comprehension ability test instrument and the environmental care attitude questionnaire have a high level of reliability with the criteria of $0.60 \leq r_{xy} \leq 0.80$ so that this instrument can be used in research.

Table 2. Reliability test results

Instrument	Cronbach Alpha	Reliability Coefficient
Reading Comprehension Test	0.744	High reliability

Data analysis technique

The data analysis techniques used are descriptive and statistical analysis to assess how much the variables being studied align with the predetermined benchmarks. The research data were statistically analyzed using the t-test technique. Hypothesis testing (t-test) uses a significance level of 5%. Before conducting the t-test analysis, assumption tests such as normality and homogeneity tests are performed first. Normality test using the Shapiro-Wilk formula and the homogeneity test using the one-way ANOVA formula (Moore, et al., 2014; Johnson & Wichern, 2018). The hypothesis testing analysis in this study uses an independent sample t-test and N-Gain Test to determine the effectiveness of using Fry graph-based digital storybooks.

Results

The results of this study are presented in two main sections that provide information on the readability of digital storybooks based on the Fry analysis and their impact on the reading comprehension skills of elementary school students.

Fry readability analysis results

The Fry Graph is used to analyze the readability of text through several steps. First, select a representative text sample of 100 words. Then, count the number of sentences in those 100 words. Next, count the total number of syllables in the sample and multiply the number of syllables by a factor of 0.6. The results of the sentence and syllable counts are then plotted on the Fry Graph. The intersection point between the number of sentences and the number of syllables on this graph will indicate the text's readability level, identified in terms of educational grade or class. Thus, the difficulty level of the text can be measured, allowing the suitability of the text for readers at a certain level to be determined.

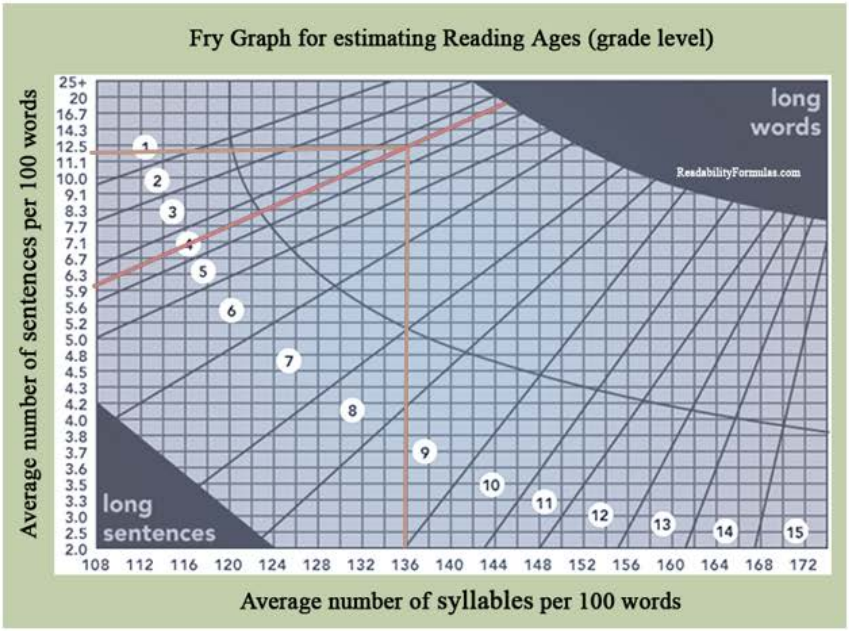

Figure 2. Results of readability analysis using the fry graph

Based on the results of the Fry graph analysis, the readability level of the digital storybook titled "The Adventures of Gavin and Owly" is appropriate for fourth-grade elementary school students. In Figure 2, the Fry graph shows that the readability outcomes illustrate a total of 12.6 sentences for every 100 words, in addition to 136 syllables per 100 words analyzed. The analysis shows that the dot is located on the number 4, according to the findings given in the study. The findings show that the text's readability within the digital storybook is appropriate for the student's grade level, which is for fourth-grade elementary school.

Students' reading comprehension

The indicators of reading comprehension include reading comprehension, conclusion drawing, text structure understanding, vocabulary usage, and evaluation. Analysis of reading comprehension ability is conducted through pre-test and post-test. Table 3 shows that all post-test percentage data in the experimental class obtained higher scores compared to the post-test percentage in the control class. This was proven in the experimental class where students showed better ability in identifying the main idea from the text they read. Students were more skilled in drawing conclusions from the entire text they read. Meanwhile, in the control class, students still struggled to identify the main idea well. Many tend to take less relevant information as the main idea.

Table 3. Pre-test score of each item question from control and experiment classes

No	Problem	Pre-Test Control Class Score (%)	Pre-Test Experiment Class Score (%)
1	Mentioning the main information from simple texts	68	75
2	Mentioning important details from the reading	52	57
3	Drawing simple conclusions based on information contained in the text	52	43

4	Concluding the meaning of the reading correctly	45	45
5	Identifying parts of the text such as titles, paragraphs, and main sentences	80	82
6	Understanding the sequence of information in the text	59	57
7	Explaining the meaning of new words found in the text	73	68
8	Using new words in appropriate sentences	73	70
9	Assessing the quality of information provided in the text (e.g., relevance and clarity)	52	59
10	Assessing whether the information in the text answers the questions or problems raised	48	43

Based on Table 3 above, the experimental class had higher pretest scores than the control class in five reading comprehension indicators (items 1, 2, 5, and 9). On items 3, 6, 7, 8, and 10, the control class scored higher than the experimental class, while on item 4, both classes achieved the same percentage score. This indicates that the reading comprehension abilities of the control and experimental classes were equivalent during the pretest phase.

Table 4. Post-test score of each item question from control and experiment classes

No	Problem	Post-Test Control Class Score (%)	Post-Test Experiment Class Score (%)
1	Mentioning the main information from simple texts	82	100
2	Mentioning important details from the reading	75	91
3	Drawing simple conclusions based on information contained in the text	61	80
4	Concluding the meaning of the reading correctly	68	75
5	Identifying parts of the text such as titles, paragraphs, and main sentences	80	100
6	Understanding the sequence of information in the text	70	80
7	Explaining the meaning of new words found in the text	73	89
8	Using new words in appropriate sentences	68	80
9	Assessing the quality of information provided in the text (e.g., relevance and clarity)	55	75
10	Assessing whether the information in the text answers the questions or problems raised	52	70

Based on Table 4, the data shows that all reading comprehension items in the experimental class had higher posttest scores than the control class. This improvement indicates that the digital storybook enhanced the reading comprehension skills of fourth-grade elementary school students.

Detailed data regarding the average, highest, lowest scores, and n-gain in both the control and experimental classes are presented in Table 5. The pretest reading comprehension scores of the experimental class were 60, while the control class scored 59.77, indicating that both classes had nearly the same reading comprehension abilities before the treatment. In the posttest, however, there was a significant difference in the average scores between the classes. The experimental class achieved an average posttest score of 83.86, which was higher than the control class's score of

70.68. The experimental class also recorded the highest score of 100, compared to the control class's highest score of 95.

Table 5. Descriptive statistics of pretest and posttest data reading comprehension skills

No.	Description	Reading Comprehension Ability Score			
		Experimental Class		Control Class	
		Pretest	*Posttest*	*Pretest*	*Posttest*
1.	Average	60	83.86	59.77	70.68
2.	N-Gain	0.63 (moderate)		0.29 (low)	
3.	Lowest Value	40	65	40	50
4.	The highest score	80	100	80	95

The analysis of the improvement in students' reading comprehension skills in the experimental class using digital storybooks showed an n-gain value of 0.63 (moderate). Meanwhile, the reading comprehension skills of students in the control class using picture media showed an n-gain value of 0.29 (low). Based on the n-gain scores, learning with digital storybooks is effective in enhancing the reading comprehension skills of fourth-grade elementary school students.

Before the hypothesis test, prerequisite tests are conducted first, namely using the normality test and the homogeneity test. Normality test using the Shapiro-Wilk formula with a significance level of 5%, which is 0.05. If the significance value < 0.05, the conclusion is that the data is not normally distributed. However, if the significance value > 0.05, then the data is normally distributed. Based on Table 6, the pretest and posttest data on reading comprehension ability in the control and experimental groups are stated to be normally distributed. Thus, it can be concluded that all research variables are normally distributed.

Table 6. Normality test results

Variables	Group	Significance Value	Level	category
Reading Comprehension Ability (pretest)	Experiment	0.398	0.05	Normal
Reading Comprehension Ability (posttest)		0.132	0.05	Normal
Reading Comprehension Ability (pretest)	Control	0.455	0.05	Normal
Reading Comprehension Ability (posttest)		0.820	0.05	Normal

Based on the results of the normality test, the pretest data for the experimental class was 0.398, and the posttest data for the experimental class was 0.132. Meanwhile, the pretest data for the control class was 0.455, and the posttest data for the control class was 0.820. Thus, all research data were normally distributed and met the requirements for hypothesis testing.

This homogeneity test is conducted to examine the similarity of several sample parts. The homogeneity test of the data is calculated using a one-way ANOVA test with the criterion that if the probability (P>0.05) then the sample is homogeneous, whereas if the probability (P<0.05) then the sample is heterogeneous. Table 7 presents the data from the homogeneity test using the one-way ANOVA formula. The conclusion is, if the significance value < 0.05 then the variance of the data groups is not homogeneous, and if the significance value > 0.05 then the variance of the data

groups is homogeneous. Based on the table above, all variables have homogeneous data variance. This is evidenced by the pretest score of reading comprehension ability obtaining a score of 0.412, and the posttest score of reading comprehension ability obtaining a score of 0.602. Thus, the overall data obtained a value greater than 0.05, indicating that all variables have homogeneous data variance.

Table 7. Homogeneity test results

Variables	Group	Mark Significance	Level	Category
Reading comprehension (Pretest)	Experiment Control	0.412	0.05	Homogeneous
Reading comprehension (Posttest)	Experiment Control	0.602	0.05	Homogeneous

The homogeneity test analysis showed that the pretest data had a score of 0.412, and the posttest data had a score of 0.602. Thus, all data obtained scores greater than 0.05, indicating that all variables have homogeneous data variance.

Hypothesis testing is conducted to answer the problem formulation and hypothesis proposed in this study. The hypothesis test used in this research is the t-test. The t-test is necessary to test the significance level of each independent variable's effect on the dependent variable partially.

Table 8 states that students' reading comprehension ability obtained a two-tailed significance value of 0.021 < (0.05) with t-observed > t-table of (2.405 > 1.682), thus it can be concluded that Ha is accepted. Thus, it can be stated that there is a significant influence of using Fry-based digital storybooks on the reading comprehension ability of fourth-grade elementary school students.

Table 8. Hypothesis testing

Variables	Thitung	Df	sig (2-tailed)	Description
Reading Comprehension	2,405	42	0.021	H_a is accepted

Based on the results of the t-test, the use of digital storybooks significantly influenced the reading comprehension skills of fourth-grade elementary school students (Ha accepted). This demonstrates that the use of digital storybooks significantly improves students' comprehension skills compared to the control group that used traditional print reading materials. This study highlights that the application of technology in literacy learning can yield better outcomes than conventional methods, with readability levels measured using Fry readability analysis.

Discussion

The research results show that the use of Fry graph-based digital storybooks can significantly improve reading comprehension skills. These findings are consistent with previous research that emphasizes the importance of integrating digital technology in education to create a more interactive and engaging learning environment (Smeda et al., 2014; Bereczki & Kárpáti, 2021). The Fry readability-based digital storybook in this study not only provides dynamic content that can be tailored to students' needs but also enhances students' reading comprehension because the text is appropriate for the grade level of elementary school students.

The aspect of readability is one of the factors considered in book development. Text readability includes the use of terminology, language clarity, and the appropriateness of language for the child's developmental level (Bellon-Ham et al, 2020). However, this aspect is often overlooked. In fact, readability is one of the important factors that must be met so that the message the writer wants to convey can be well received by the reader (Gosselin, Le Maux & Smailli, 2021). Text or teaching materials with a readability level that does not match the cognitive capacity of students can affect their ability to understand the information or message conveyed through the text.

Students' reading comprehension skills experienced a significant improvement after being treated with Fry-based digital storybooks. This aligns with the findings of Clark & Mayer (2023), which indicate that interactive learning materials can help students better understand and absorb information. The use of technology allows for real-time content adjustments, which can be tailored to the reading levels of students, thereby minimizing comprehension gaps among students with varying reading skills.

Fry's graph-based digital storybooks provide an interactive approach, where materials can be presented dynamically according to the needs of the students. This is in line with the findings of the research by Yurtseven, O'Dwyer & Lawson (2020) that the integration of technology in learning can enhance student engagement in learning and improve their understanding of complex concepts. Elementary school students involved in this research showed an improvement in reading comprehension through the use of digital-based books, especially in the context of understanding disaster mitigation. Technology-based textbooks can adjust the difficulty level of the text to match each student's ability, thereby supporting a more effective learning process (Alqahtani, 2020).

Reading comprehension skills encompass students' ability to understand the meaning of a text, draw conclusions, and apply the information obtained to new contexts. This research shows that Fry's graphic-based digital storybooks not only improve basic reading comprehension skills but also enhance students' critical thinking skills. This is also supported by findings from Walter (2024) that the use of smart technology in literacy learning accelerates the learning process, especially in understanding informative and technical texts. Additionally, students who used Fry's graph-based digital storybooks successfully answered 90% of the reading comprehension questions correctly, compared to only 70% of the control group who used traditional textbooks. This fact strengthens the argument that the use of technology can enhance the effectiveness of literacy learning among elementary school students.

The Fry graphic-based digital storybook can present information in a more engaging way suitable for children's age, where it can be used to provide visualization, simulation, and automatic material adjustment according to students' abilities (Lewis, 2018). Content that is relevant to students' daily lives can increase interest and motivation to learn (Sahudra, et al. 2024; Zunariyah, et al., 2018). Students are also better able to relate the information they obtain to real-life situations, such as knowing how to act during an earthquake or flood.

Although digital-based books show great potential in improving students' reading comprehension skills, several challenges need to be considered in their implementation. One of the challenges identified in this research is the need for adequate technological infrastructure in elementary schools. This is in line with the statement from the research by Aderibigbe, et al (2023) that the integration of technology in education is often hindered by infrastructure limitations in schools with limited resources. Fry's graphic-based digital storybooks can provide a personalized experience tailored to each student's reading level, where technology can offer additional explanations when students encounter difficulties.

Conclusion

This study aims to test the effectiveness of digital storybooks based on Fry's Readability Graph on the reading comprehension abilities of elementary school students. The experimental method with a pretest-posttest control group design was used, involving fourth-grade students as the sample. Data was collected through reading comprehension tests. The research results show that Fry readability-based digital books effectively improve reading comprehension, with the experimental class (medium) having a higher n-gain test than the control class (low) and a significant t-test. This finding confirms that grade-level appropriate and digital-based books can enhance students' interest and reading skills. The limitation of this study lies in its scope, which is restricted to only fourth-grade students at a single elementary school, thus the results cannot yet be generalized to a broader population. The recommendation for future research is to expand the scope of the study to more schools and different grade levels to observe the consistency of the results.

Declaration of conflicting interest
The authors declare that there is no conflict of interest in this work.

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