A Psycholinguistic Perspective on the Effectiveness of Digital Technologies on Reading Achievement of School-Aged Children with Dyslexia

Ayat Mohamed Mohamed Fathalla PhD in Mental Health from the Faculty of Education, Sadat City University

Abstract

This study aims to investigate the effectiveness of digital technologies on the reading achievement of school-aged children with dyslexia. This study employed a quantitative approach using a quasi-experimental, pre-test and post-test design to investigate the effectiveness of digital technologies on the reading achievement of school-aged children with dyslexia. The sample was divided into three groups, equal in number, and with the same age as they were from grade one: control (n=10 children), print storytelling (n=10 children), and digital storytelling (n=10 children). Findings indicated a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on all test scores in post tests. It is noted that people with learning disabilities need to employ modern strategies such as e-learning and supporting technologies of all kinds in the educational process.

Keywords: digital technologies, reading achievement, schoolaged children, dyslexia

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1. Introduction

Dyslexia is a common term that refers to specific reading difficulties which can be classified as a Specific Learning Disorder (SLD) (According to the American Psychiatric Association, 2013). The American Psychiatric Association considers SLD to be a type of neurodevelopmental disorder that impedes the ability to learn or use specific academic skills such as reading, writing, or arithmetic (Makgato et al.,2022). It is a learning disorder that involves difficulty in reading due to problems in identifying speech sounds and learning how they relate to letters and words (decoding) (Mattke,2021).

The Clinic Guide to Raising a Healthy Child (2017) declares that the symptoms of some early clues of dyslexia may include late talking, learning new words slowly, challenges in forming sounds correctly, such as, reversing sounds alike, challenges in remembering or naming letters, numbers and colors, learning nursery rhymes as well as playing rhyme games. Diagnostic evaluations of dyslexia often cover background information, including family history and early development, intelligence, oral language skills, word recognition, fluency skills, reading comprehension, vocabulary knowledge, decoding, and phonological processing.

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Makgato et al. (2022) point out that: "Children with dyslexia often have associated deficits in certain related domains such as oral language acquisition, writing abilities, mathematical abilities, motor coordination, postural stability and dexterity, temporal orientation, visuospatial abilities and dexterity, and attention abilities". (p. 1)

Reading is the process of receiving and decoding information encoded in language form via the medium of print (Özkan, 2022). It is a complex process requiring various literacy skills to achieve proficiency (Tanju & Hakkoymaz, 2022). Eissa (2015) identified five key elements of reading: phonemic awareness, phonics, vocabulary, fluency, and comprehension.

Reading ability is stated as necessary for every citizen to be able to participate in education, employment, and society. A significant part of the activities in school is based on this ability. In school today, this skill is required for further learning and knowledge acquisition (Fälth & Selenius, 2022).

Reading stages can be classified into three stages: Prereading, During-reading, and Post-reading; Pre-reading stage: The Teacher activates students' background knowledge and connects what they already know with what they are learning in school. The teacher helps students identify the structure and organization of ideas in the text; during the reading stage,

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learners identify new information in the activities, explaining similarities between new information in the text and what they already know. Reconciling information in the text that contradicts what they already know. Forming questions about what they cannot know and rechecking the text for the information. Post-reading stage: students summarize the text after reading it, evaluating the text, stating the main idea, and the topic of the text (Ibrahim,2020).

Reading is a multi-sensory experience. According to research, the brain's act of reading uses not just sight, but also the act of touch. There is something about holding a physical page of material that makes it more absorbable. "The shift from paper to screen does not just change the way we navigate a piece of writing. It also influences the degree of attention we devote to it and the depth of our immersion in it." (Carr 2011).

Advances in digital technology have changed the learning resources and materials available to teachers and students (Mah, Hu& Yang,2021). These technological advances have created potential in many educational areas and can be used as a medium for promoting children's literacy skills.

The growth of Information and Communication Technology (ICT) has revolutionized the educational process in the twenty-first century, and the use of ICT in the educational

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process may assist teachers and students in discovering information pertinent to their education (Nair& Yunus,2022).

Digital stories are used in education to introduce new material, encourage conversation, and make abstract or conceptual topics more intelligible. Using multimedia in the classroom assists with the retention of new knowledge and the comprehension of complex subjects (Nair & Yunus,2022). Students who make digital stories learn to organize their thoughts, ask questions, voice their opinions, develop narratives, and communicate their ideas and information in a unique and relevant manner (Nair & Yunus,2022). ICT strategies, such as digital storytelling, have been shown to dramatically improve learners' performances, literacy, and capacities.

Any digital technology necessary to support an individual student achieve the goals set out by the education plan or curriculum is regarded as assistive technology (Fälth & Selenius,2022). Assistive technology allows students to increase, maintain, or improve their functional capabilities. Hence, assistive technology is emphasized as an essential tool for enabling all students to participate in education (Fälth & Selenius,2022).

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Liu (2005) reported that there is a change of reading behavior from a traditional, print-based pattern to an emerging screen-based pattern. The use of digital technology produces such a change in reading behavior among people (Mah et al.,2021). Thiessen and Dianne (2007) found that there is a curvilinear relationship between Canadian adolescents' use of digital technology and their reading achievements, suggesting that the optimal use of digital technology matters in enhancing reading abilities. Larson's (2015) study also revealed that the digital reading experience would support sixth-grade students' vocabulary development and interests in reading.

Storytelling has always been at the core of human activity (Maureen et al.,2018). Integrating information and communication technologies (ICT) yielded a form of digital storytelling (Brígido-Corachán and Gregori-Signes 2014). Digital storytelling revolves around presenting short, personal narratives (Meadows 2003) that combine images with text, narration, voice, and music (Robin 2008).

Several studies with older children have shown that digital storytelling can generate children's interest and learning motivation and facilitate their understanding of complex subject matter (Robin 2008; Sadik 2008).

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Effects of digital storytelling on children have been investigated for math or ICT, but not reading skills (Maureen et al.,2018). The relationship of digital storytelling to children's overall reading development in school-aged children with dyslexia needs to be investigated.

1.1.Aim

The aim of this study is to investigate the effectiveness of digital technologies on the reading achievement of school-aged children with dyslexia.

1.2.Hypotheses

The following hypotheses are to be tested.

- H.1.: There will not be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the alphabet knowledge test in post-test.
- H.2. : There will not be a significant difference between the three groups (I.e. control, storytelling, and digital storytelling) on the phonological awareness test in posttest.
- H.3. : There will not be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the print awareness test in post-test.

2. Method

2.1.Research Design

This study employed a quantitative approach using a quasiexperimental, pre-test and post-test design to investigate the

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effectiveness of digital technologies on the reading achievement of school-aged children with dyslexia.

2.2.Participants

Children are recruited from two primary schools in Nasr City. All the children are to fulfill the following inclusion criteria, according to APA, 2013, : (a) Inaccurate or slow and effortful word reading (b) Difficulty understanding the meaning of what is read; (c) Difficulties with spelling, and (d) reading and spelling achievement equal to or below 1 SD (\leq 85), consistent with the definition of dyslexia. Children for this study were chosen using the purposive sampling technique, which is based on the learners' ages (7 years old) and levels of Arabic language competence (intermediate and low). The sample was divided into three groups, equal in number, and with the same age as they were from grade one: control (n=10 children), print storytelling (n=10 children), and digital storytelling (n=10 children).

2.3. Data Collection

2.3.1. Instruments.

Alphabet knowledge test: This test was developed particularly for this study. It measures the ability of children to name, distinguish shapes, write, and identify the sounds of the alphabet (Piasta and Wagner 2010). This test consists of fifteen

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items, multiple-choice forms, e.g., What is the name of this kitchen item?

- a) basin
- b) refrigerator
- c) washing machine
- d) oven



The correct answer is given one point while the incorrect one is given zero. The composite score for the whole test is fifteen points. A group of five experts examined the content validity. They indicated whether questions were irrelevant or highly relevant. All items were highly relevant. A content validity index at the item level (I-CVI) = 0.90. The internal consistency of the test was measured through Cronbach's alpha, estimated at 0.83.

Phonological awareness test: This test was developed particularly for this study. Phonological awareness has been measured and consequently defined by many different tasks. One of them is Blending Phonemes (BP): This task requires the child to synthesize or blend each sound in the word. For example, /k//i//t/e/ (15 items).

The correct answer is given one point while the incorrect one is given zero. The composite score for the whole test is

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fifteen points. A group of five experts examined the content validity. They indicated whether questions were irrelevant or highly relevant. All items were highly relevant. A content validity index at the item level (I-CVI) = 0.90. The internal consistency of the test was measured through Cronbach's alpha, estimated at 0.81.

Print awareness test: This test was developed particularly for this study. This test measures a child's ability to recognize names in written form. This test consists of fifteen cards, where there are ten cards for which children are asked to say how many letters are in the word, and five cards for which children are asked to say how many words are in the Sentence.

The correct answer is given one point while the incorrect one is given zero. The composite score for the whole test is fifteen points. A group of five experts examined the content validity. They indicated whether questions were irrelevant or highly relevant. All items were highly relevant. A content validity index at the item level (I-CVI) = 0.90. The internal consistency of the test was measured through Cronbach's alpha, estimated at 0.82.

2.4. Data Analysis

Seven children of the thirty-one children participating in the intervention study did not complete both the pretest and posttest

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because of absence. We used only complete data for the twentyfour children who completed all assessment tasks in the final analyses.

The distribution of scores on the three measures in the pretest and posttest violated measurement assumptions for normality and homogeneity of variance. Thus, findings are reported using nonparametric tests (i.e., Friedman test: alternative for ANOVA with Repeated measures).

2.5. Procedure

Three phases were employed for the intervention study: pretest (the first week), implementation (four weeks' time), and post test (during the sixth week). In the pretest, the three groups of five children gathered in the technology room of the school, where the experimenter and the classroom teacher were present. Both were engaged with children for the assessments. Administration of the tests took 30–40 minutes for all children.

The control group children participated in the regular reading-focused classroom activities led by the teacher. During the implementation phase, for the two intervention groups (storytelling and digital storytelling), the activities were given by the two researchers, one for each intervention group. The overall structure of these activities was the same in both conditions. First, there was storytelling. Next, there was a

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whole-class discussion about the story, and finally, there were follow-up activities. For each storytelling session, the researcher stated the rules for the session and prepared the children for the story by informing them about the title, characters, and main idea.

In the oral storytelling condition, the researcher read the story aloud, presenting some visual clues and cards to the children. While for the digital storytelling group, all is presented through a computer presented on the smart whiteboard.

The posttest was administered in the week following the activity sessions with a similar procedure to the pretest sessions.

3. Findings

To verify the first hypothesis, which states " There will not be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the alphabet knowledge test in posttest", the Friedman test was used. As shown in Table 1., there are significant differences between the three groups. Next Mann-Whitney U was used. As shown in Table 2.:

a) There is a significant difference between the control and storytelling groups on the alphabet knowledge test in post post-test in favor of the storytelling group

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- b) There is a significant difference between the control and digital storytelling groups on the alphabet knowledge test in post post-test in favor of the digital storytelling group
- c) There is a significant difference between storytelling and digital storytelling groups on the alphabet knowledge test in post post-test in favor of the digital storytelling group

Hence, the null hypothesis is rejected, and the alternative hypothesis is accepted, which states " There will be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the alphabet knowledge test in posttest".

Table 1.									
Friedman test results for the Alphabet knowledge test									
group	Ν	Μ	SD	Chi	df	Sig.			
				Square					
control	10	5	1.154	20	2	.000			
Exp.1	10	9.6	.966						
Exp.2	10	12.4	.516						

Table 2. Mann-Whitney Test results for the Alphabet knowledge test									
test	Ν	Mean Rank	Sum of Ranks	Mann- Whitney	Z	Sig.			
		IXumix	Runns	U					
Alphabet	control	5.5	55	.000	-3.818	.000			
knowledge	Exp.1	15.5	155	-					
test	control	5.5	55	.000	-3.863	.000			
	Exp.2	15.5	155	.000	-				
	Exp.1	5.5	55	.000	-3.867	.000			
	Exp.2	15.5	155	.000	-				

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To verify the second hypothesis, which states " There will not be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the phonological awareness test in post-test", the Friedman test was used. As shown in Table 1, there are significant differences between the three groups. Next Mann-Whitney U was used. As shown in Table 4.:

- a) There is a significant difference between the control and storytelling groups on the phonological awareness test post-test in favor of the storytelling group
- b) There is a significant difference between the control and digital storytelling groups on the phonological awareness test in post-test in favor of the digital storytelling group
- c) There is a significant difference between storytelling and digital storytelling groups on the phonological awareness test in post-test in favor of the digital storytelling group

Hence, the null hypothesis is rejected, and the alternative hypothesis is accepted, which states " There will be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the phonological awareness test in post-test".

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Table 3.								
Friedman test results for the Phonological awareness test								
group	Ν	Μ	SD	Chi	df	Sig.		
				Square	<u>!</u>			
control	10	5.20	.918	20	2	.000		
Exp.1	10	10.00	.666					
Exp.2	10	12.20	.632					

Table 4.

Mann-Whitney Test results for the Phonological awareness test							
test	Ν	Mean	Sum of	Mann-	Ζ	Sig.	
		Rank	Ranks	Whitney			
				U			
Phonological	control	5.5	55	.000	-3.866	.000	
awareness	Exp.1	15.5	155				
test	control	5.5	55	.000	-3.869	.000	
	Exp.2	15.5	155				
	Exp.1	5.5	55	.000	-3.819	.000	
	Exp.2	15.5	155				

To verify the second hypothesis, which states " There will not be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on print awareness test in post test", the Friedman test was used. As shown in Table 1, there are significant differences between the three groups. Next Mann-Whitney U was used. As shown in Table 6.:

- a) There is a significant difference between the control and storytelling groups on the print awareness test in posttest in favor of the storytelling group
- b) There is a significant difference between the control and digital storytelling groups on the print awareness test in post post-test in favor of the digital storytelling group

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c) There is a significant difference between storytelling and digital storytelling groups on the print awareness test in post-test in favor of the digital storytelling group

Hence, the null hypothesis is rejected, and the alternative hypothesis is accepted, which states " There will be a significant difference between the three groups (I.e., control, storytelling, and digital storytelling) on the print awareness test in post-test".

Table 5.								
Friedman test results for the Print awareness test								
group	Ν	Μ	SD	Chi	df	Sig.		
				Square				
control	10	4.50	.971	19.538	2	.000		
Exp.1	10	9.60	1.07					
Exp.2	10	11.70	.823					

			I able 6.						
Mann-Whitney Test results for Print awareness test									
test	N	Mean Rank	Sum of Ranks	Mann- Whitney U	Z	Sig.			
Print	control	5.5	55	.000	-3.830	.000			
awareness	Exp.1	15.5	155	_					
test	control	5.5	55	.000	-3.865	.000			
	Exp.2	15.5	155						
	Exp.1	6.10	61	6	-3.413	.000			
	Exp.2	15.5	155	_					

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4. Discussion

This study aims to investigate the effectiveness of digital technologies on the reading achievement of school-aged children with dyslexia. Findings indicated that there was a

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significant difference between the three groups (I.e., control, storytelling, and digital storytelling) in all test scores in post tests.

This result is consistent with those of Benmarrakchi et al. (2017), who addressed the role of information and communication technology (ICT) in supporting dyslexic students. They indicated that most students who suffer from dyslexia tend to be visual learners (Benmarrakchi et al., 2017).

Effective digital stories had many criteria, including: defining clear behavioral goals in the content of the digital story, clearly describing the content of the digital story, so that it is derived from the objectives and is characterized by integration and sequence, and the presence of activities commensurate with the educational goals in the content of the digital story, and taking into account the structure When designing the digital story, and following an appropriate design model, the artistic design of the digital story is suitable for display, and the scenario followed is clear, and it included an appropriate number of images, texts, sounds, video clips, and animations.

These media were appropriately integrated with each other. In order to achieve the goal of the story, and there was a degree of compatibility and harmony between the audio and visual components, and to lead the viewer to contemplation and

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thinking, and that the story has moved away from the quick display of images and rapid sound tones, and in it the movement that attracts focus to the events of the story was chosen, and the images that could be chosen It conveys feelings and emotions, and includes a fast rhythm in narrating events that require excitement, and includes a slow or normal rhythm in narrating events that require relaxation. And meditation. The availability of these criteria, or most of them, has made the digital story effective in achieving the desired benefit from it.

The educational value of the digital story is that it is a positive process that generates an atmosphere of fun and excitement, and supports the appropriate employment of information technology media, in addition to being suitable for all fields of study. It is a powerful tool for visual and auditory learning and serves as the scaffolding that connects the school and the surrounding community (Kazakof, 2015). It is a powerful community education tool, which confirms its positive role in teaching young people basic skills and providing them with the necessary knowledge and information.

The digital storytelling activities had a significant effect on the children's reading achievement (Ng,2015). Whereas the children in the control condition showed slight improvement

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across the intervention period, the children in the experimental conditions achieved significant gains in reading achievement.

Digital storytelling is a meaningful and inspiring activity that has a significant impact on students and their learning experiences. Thus, digital stories promote learner engagement by allowing them to reflect on the learning process, use technological tools (Nair& Yunus, 2022). Furthermore, the digital storytelling method allows learners to become members of a community with their peers, work, engage, and cooperate with them, and therefore build interpersonal and communication skills (Nair& Yunus, 2022).

5.Recommendations

Future research could utilise the digital storytelling application among larger groups of children, such as students from different grades and geographical areas. In addition, this study can be carried out on a larger scale, encompassing numerous students with learning disabilities. For this research, there were only twenty-four children from two schools in Baltim city involved, and the results were convincing and encouraging. Thus, based on this positive outcome, the application has the potential to be applied in a different setting. Digital stories can be effective to enhance children's listening and comprehension skills.

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6.Conclusion

It is noted that people with learning disabilities need to employ modern strategies such as e-learning and supporting technologies of all kinds in the educational process. Therefore, they need to harness these educational techniques in their education and achieve the goals of the integration process and the individual educational plan that deals with the learner individually. Based on his strengths and weaknesses, all these goals will not be achieved except through appropriate educational strategies for them, according to their capabilities.

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Statements and Declarations

The authors reported no potential conflict of interest.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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