

Metasynthesis on the Impact of Game-Based Digital Applications on the Reading Proficiency of Dyslexic Students

Bee Jay D. Olitres, Alsed R. Veliganilao, Analiza M. Alipao,
Ana Marie M. Ortega, Erma A. Ynot, Mauren Kaye A. Masong
Cebu Normal University, Medellin Cebu, The Philippines

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ABSTRACT

Developmental Dyslexia (DD) is the most common and serious reading disability that hinders the student's capability to read. This meta-synthesis study aims to know the effects of game-based digital applications on developmental dyslexic students' reading proficiency. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement flowchart, the researcher initially registered six hundred twenty-seven (627) studies from Google Scholar, Core.ac.uk, and Eric.edu.gov databases using the Boolean search strategies. Handsearching the reference lists of the eligible papers yielded forty-seven (47) related papers. After subjecting the papers to the inclusion and exclusion criteria, fifteen studies were selected and included in the final review. Clarke et al.'s thematic analysis of the data extracted from the papers yielded the four themes: 1) benefits of game-based digital applications for dyslexic students; 2) challenges and distractions; 3) usability and effectiveness of instructional applications; and 4) motivation and academic achievements. Overall, game-based digital applications have the potential to positively impact the reading proficiency of dyslexic students. However, it is essential to address the challenges and distractions that students may face while using these applications. By integrating the recommendations of this study into educational practices, educators can create inclusive learning environments that promote the academic success of dyslexic students.

Keywords: *Developmental Dyslexia, game-based digital application, reading proficiency, inclusive education, metasynthesis*

INTRODUCTION

Students all over the world are taught to read from an early age because reading skills are very important since reading opens up the chance to absorb existing knowledge (Ganie et al., 2019). Learning to read is also a central objective of early education, and difficulties with reading can have serious consequences (Hulme & Snowling, 2015). According to the OECD (2013), one of the primary goals of early childhood education is to teach learners to read fluently and comprehend a text because the primary goals of reading are to attain one's objectives, develop one's knowledge and ability, and contribute to society. However, some of them struggle with it due to a variety of factors. These factors may include working memory, prior knowledge, vocabulary, reading

strategies, motivation to read, word recognition, and disabilities (Sanford, 2015). Moreover, for more than a century, scientists have been studying poor reading, also known as reading difficulty, reading impairment, reading disability, reading disorder, and developmental dyslexia (McArthur & Castles, 2017). Developmental dyslexia (DD) is the most common and serious reading disability that hinders the student's capability to read (McDowell, 2018). It (i.e., DD) is a specific disability defined by significant and persistent difficulties in learning to read and communicate that are not caused by mental age, visual acuity issues, or insufficient schooling (World Health Organization, 2016). The Yale Center for Dyslexia and Creativity reported that dyslexia affects 20%

of the population and accounts for 80–90% of all learning disabilities (Shaywitz, 2020). A large proportion of dyslexic individuals are at a higher risk of academic and social issues as a result of their dissatisfaction with reading (Volkmer, 2018). These children frequently exhibit greater levels of reading anxiety (Carroll, 2006), have decreased confidence in their English abilities (Knight, 2021), and have negative attitudes (Hutton et al., 2021). Dyslexia is quite common but has an unknown frequency, ranging from 5% to 17.5%, and the discrepancy in incidence may be due to several causes (Peterson & Pennington, 2012).

Dyslexia is not common in Asia, yet the number of those affected is enormous (San Jose, 2012). Studies show that 10% or so of Singaporeans suffer from dyslexia. Although there has been more support for dyslexic kids in recent years from the Ministry of Education (MOE) and the Dyslexia Association of Singapore (DAS), it is still insufficient (Landulfo et al., 2015).

Moreover, many dyslexic students struggle with English language skills and grammar and fail to achieve outcomes that represent their ability. Problems with decoding, fluency, and understanding can influence growth, and this is especially true in Singapore, where primary school achievement is very important (Leong, 2015).

In the Philippines, many people are still perplexed by dyslexia. The researcher has not come across any statistics indicating the incidence of this condition among college or university students (San Jose, 2012). The country's Department of Education (DepEd) mandate is to serve all of the nation's students, including those with special needs like dyslexia, in addition to regular, gifted, and talented students, but research indicates that students with special needs have limited access to and participation in education and that their needs are not being specifically met (Anulao & Dela Cruz, 2022). These groups of learners must be given special attention because they struggle with communicating and also because of their challenges with reading and recalling the form and content of what they want to say (Vanderbilt University, 2020).

Because of this dismal scenario, educators are scrambling to find ways to improve the reading proficiency of dyslexic students. One of these is

the utilization of game-based digital applications. Game-based learning is the application of specific game elements to real-world settings to engage students (Trybus, 2015). Game-based learning is the future of education since the younger generation has grown up playing computers, resulting in a positive view and willingness to utilize games for additional learning (Ibrahim et al., 2018) and use these methodologies to attain their focus (Hanus & Fox, 2015). Due to the substantial potential of game-based learning apps and their influence on students (Silva et al., 2020), it is possible to increase both intrinsic and extrinsic motivation in games developed for educational purposes (Araujo, 2016). Vasalou et al.'s, (2017) concluded that game-based learning is effective because students spontaneously engage in "game talk" about game performance, content, actions, and experiences. Moreso, educational software plays a crucial role in assisting students with dyslexia to read better in Arabic because the functionalities in the game can be an aid to dyslexic students in the learning process (Ishak et al., 2021).

The purpose of this meta-synthesis is to synthesize and analyze the existing research on the use of game-based digital applications to improve reading proficiency and overall academic outcomes for students with dyslexia. By conducting a rigorous meta-synthesis, we aim to provide clear, evidence-based guidance that can inform the development and implementation of game-based learning tools specifically designed to support dyslexic learners. The expected output of this meta-synthesis is a set of actionable recommendations for educators, instructional designers, and educational technology developers on best practices for leveraging game-based approaches to create inclusive and effective learning experiences for students struggling with dyslexia. This meta-synthesis seeks to be a valuable resource that empowers schools and teachers to utilize innovative digital tools to promote the academic success of this underserved population.

METHODOLOGY

This systematic review synthesizes various studies to find out how game-based digital

applications affect the reading proficiency of developmental dyslexic students. Meta-synthesis is an essential method for obtaining significant insights into the field of qualitative research (Chrastina, 2018) and also for analyzing the results of published qualitative research studies to create new interpretations. In this paper, we synthesized available data on the effects of game-based digital applications on the reading proficiency of dyslexic students.

Search Strategy

All the journal articles and grey literature relevant to the language game-based digital application's effect on the reading proficiency of dyslexics were searched from the Google Scholar, Core.ac.uk, and Eric.ed.gov databases. Then, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram (see Page et al., 2021), articles were retrieved and evaluated for inclusion in the review. The search strategy used was the Boolean searching strategy. A research query can be transformed into a search string using the Boolean search approach, which can then be utilized to find pertinent publications using online databases or search engines (Aliyu, 2017). Furthermore, only research resulting from typing the following keywords in the specified databases will be examined which are "game-based", "digital application", "reading proficiency", and "dyslexic students or dyslexic learners". Three search strings were utilized in the database searching (see Table 1).

Full copies of the papers discovered through the online search and deemed to fit the inclusion criteria based on their title, abstract, and subject descriptors were retrieved and evaluated. Articles found by handsearching the reference list and conducting bibliographic searches on the shortlisted articles were also considered. All reviewers picked the papers individually based on the inclusion criteria and the Critical Appraisal Skills Programme (CASP) checklist 2018 (CASP, n.d.). Disagreements in reviewer selections were handled at a reviewer meeting before selected articles were decided for inclusion in the review.

Table 1. Search strings used in the database surfing

Database	Search String
Google Scholar	"games" AND "digital" AND "application" AND "reading proficiency" AND ("dyslexic students OR "dyslexic learners") AND "qualitative study"
Core.ac.uk	"game-based" AND "digital application" AND ("reading proficiency" OR "reading mastery" OR "reading fluency") AND ("dyslexic students" OR "dyslexic learners") AND ("qualitative study" OR "case study" OR "survey" OR "phenomenology" OR "narrative")
Eric.edu.gov	"game-based" AND "digital application" AND ("reading proficiency" OR "reading mastery" OR "reading fluency") AND ("dyslexic students" OR "dyslexic learners")

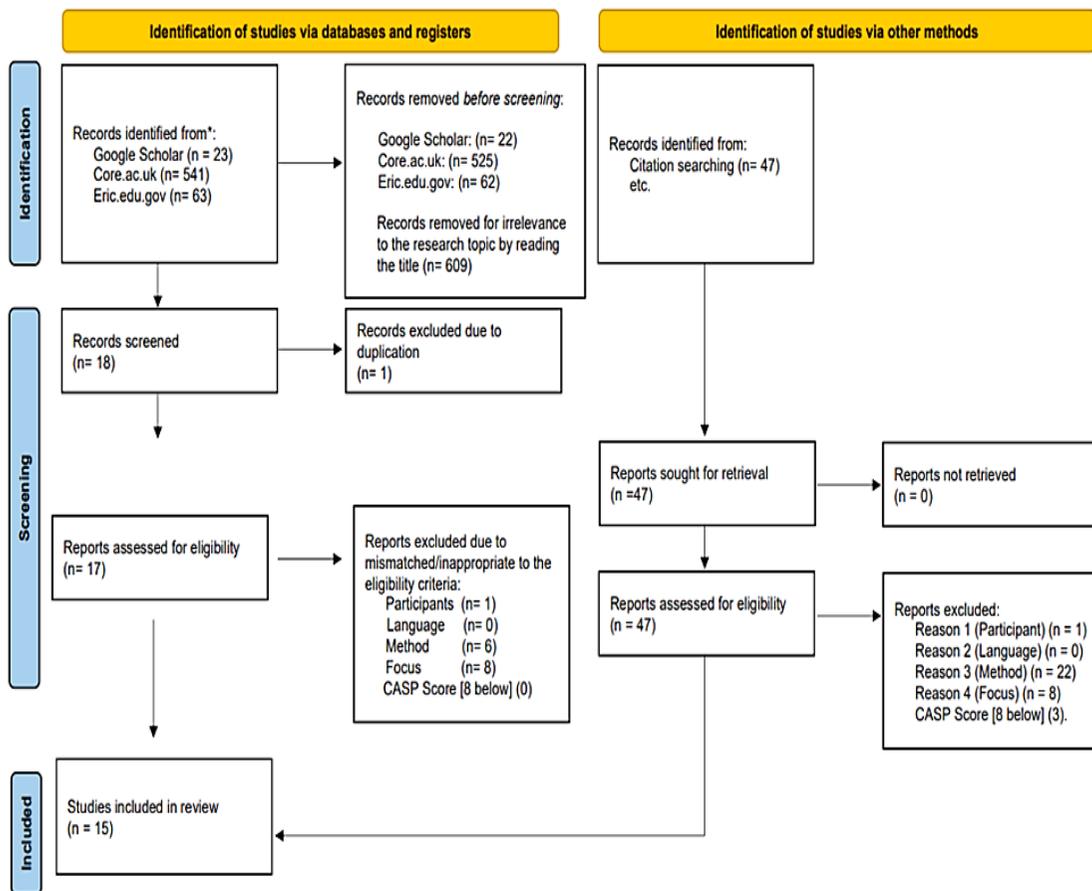
Inclusion/Exclusion Criteria

The following are the criteria for incorporating articles in this review: studies relevant to the researchers' issue; all research studies related to the problem regardless of the setting; participants must be dyslexic students regardless of educational levels (college, high school, elementary, and primary students); methods must be qualitative (case study, descriptive qualitative, exploratory, ethnographic, phenomenology, narrative, action research, and mixed method); year of publication must be from 2012-2022; publication format must be conference proceedings, published or unpublished thesis and dissertation, and journal articles. Moreover, only English-language studies will be considered as a medium for reporting. Duplicate publications are also removed. Finally, the articles that were initially gathered will be thoroughly evaluated by the researchers against the CASP qualitative checklist 2018 and must have received a total score of eight (8) or above to make it to the final list. Papers beyond the scope mentioned in the inclusion criteria were appropriately excluded.

Search Result

The selection procedure for research papers is depicted in Figure 1.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>

Figure 1. Identification of studies following the PRISMA flowchart and searching the databases and registers as well as other methods

The PRISMA Flow Diagram is used to organize the research article selection process into three (3) phases. Identification, screening, and inclusion are the three phases.

During the identification stage in database searching, twenty-three (23) studies were registered in Google Scholar, five hundred forty-one (541) studies were registered in the Core.ac.uk database, and sixty-three (63) studies were registered in Eric.gov.edu, for a total of six hundred twenty-seven (627) studies. Also, handsearching the reference lists of the eligible studies yielded forty-seven (47) papers. By reading the title and abstract, as well as

subsequently subjecting the papers to the inclusion and exclusion criteria, fifteen studies were eligible to be included in the final review.

Data Analysis

This study utilizes thematic analysis since it permitted the researchers to be flexible when it comes to interpreting data and addressing massive data sets by organizing them into major themes. The extracted data were evaluated and interpreted using the thematic analysis of Braun and Clarke's (2006) protocol.

The researchers first familiarized and analyzed the data, then assigned preliminary codes to the qualitative data to describe the content, and look for patterns or themes in the codes. Themes were then defined and named and finally, the report was produced.

RESULTS AND DISCUSSIONS

The final collection of fifteen (15) studies included in the review is seven (7) research journal articles, two (2) dissertations, two (2) theses, and four (4) conference papers. The preceding table (see Table 2) presents the different studies and the different game-based digital applications they employ in their studies to improve the reading proficiency of dyslexic learners.

Table 2. Summary of studies included in the review and their characteristics

Study no.	Author & publication year	Setting	Publication type	Design	Game-based digital applications used
1	Arteaga & Rivera (2018)	Mexico	Conference Paper	Case Study	1. Educational Application
2	Elazab Elshazly (2018)	United Arab Emirates	Thesis	Case Study	1.iPad intercession program with multi-sensory applications
3	Sekovanić et al., (2012)	Croatia	Conference Paper	Case Study	1. Moodle 2. iShed E-book editor
4	Lukeš (2015)	United Kingdom	Journal Article	Exploratory Research	1. Dyslexia Friendly Reader App
5	Rodríguez-Cano et al. (2021)	Spain	Journal Article	Interpretative with Descriptive Research	1. Virtual Reality Application
6	Puradireja (2022)	Indonesia	Journal Article	Case Study	1. Learn Letters application
7	Gooch et al. (2016)	United Kingdom	Conference Paper	Exploratory Inductive Case Study	1. classDojo
8	Borhan et al. (2018)	Malaysia	Journal Article	Mixed Method	1. Mr. Read V2.0
9	Allafi et al. (2022)	Saudi Arabia	Conference Paper	Mixed Method	1. The Proposed Game-based Mobile Application
10	Russell (2019)	New Zealand	Thesis	Action Research	1. Catch 2. Falling Words
11	Barden (2012)	United Kingdom	Journal Article	Case Study and Action Research with an ethnographic sensibility	1. Web 2.0 “Facebook”
12	Skiada et al. (2014)	Greece	Journal Article	Mixed Method	1. Easylexia
13	Agama & Gómez (2021)	Ecuador	Journal Article	Descriptive Research	1. DyetectiveU app
14	TEMAGOULT(2020)	Algeria	Dissertation	Mixed Method	1. Aidodys Application
15	Coker (2022).	United States of America	Dissertation	Exploratory Study	1. MagicSpells

The game-based digital applications were designed and utilized as an intervention for dyslexic students to gain access to learning and improve their reading aptitude. Upon subjecting thematic analysis to the extracted data from the reviewed paper there are four (4) themes which emerged: 1) benefits of game-based digital applications for dyslexic students; 2) challenges and distractions; 3) usability and effectiveness of instructional applications; and 4) motivation and academic achievements.

Theme 1: Benefits of Game-based Digital Applications for Dyslexic Students

During learning in face-to-face classes or even in the online mode of teaching, game-based digital applications are beneficial to the reading proficiency of dyslexic students. It helped improve their reading and vocabulary skills as well as increased their reading enjoyment and engagement.

The game-based digital applications had made progress in the reading, word recognition, and phonological decoding abilities of dyslexic students (Arteaga & Rivera, 2018; Rodríguez-Cano et al., 2021; Skiada et al., 2014). For instance, Easylexia's specially designed dyslexia-friendly font (Open Dyslexic), simplifies the process of reading and word and letter recognition (Skiada et al., 2014). Additionally, the iLearnRW Reader prototype's interface highlights words that are common or those that have challenging patterns before the reader sees a text (Lukeš, 2015). These applications aided students because, through its game activities, their reading proficiency has increased compared to their typical level (Lukeš, 2015; Borhan et al., 2018). Elazab Elshazly (2016) claims that some parents highlighted the development of abilities as a benefit of utilizing the iPad app, and it can also help students feel happy and inspired to learn (Puradiredja, 2022). According to Lukeš (2015), since the replay feature is featured in the reader interface, even those students who normally have a negative attitude toward reading were motivated to access the books frequently. This reason adds to the encouragement of students to read and write carefully to learn more or to compile a summary

of what they have learned (Barden, 2012). The amount of time dyslexics spend reading was also considerably reduced by using texts modified by Aidodys (TEMAGOULT, 2020). Therefore, rather than having to memorize a list of common terms for papers, dyslexic students were able to learn vocabulary via the application more quickly (Coker, 2022).

The game-based digital applications offer significant benefits for dyslexic students, including improvements in reading, word recognition, phonological decoding, and vocabulary acquisition. By engaging dyslexic students through interactive and game-like activities, these applications provide a stimulating and effective learning environment.

Theme 2: Challenges and Distractions

Game-based digital applications also have some disadvantages to the reading proficiency and learning motivation of dyslexic students. While these applications have proven to be beneficial in various aspects, learners have also experienced certain challenges and distractions that can hinder their effectiveness.

For example, when using smartphones to access the application, student is easily distracted by watching YouTube and playing game (Puradireja, 2022). Moreover, personal challenges such as mood swings (Puradireja, 2022), and specific difficulties in decoding phonemes (Rodríguez-Cano et al., (2021) impede the dyslexic students' reading progress. Technological challenges such as the applications' difficulty of use (TEMAGOULT, 2020), the small text size of the e-learning course in the Moodle system (Sekovanic et al., 2012), and the issues with toolbar features and menus, voice recording and playback, assessments, etc., (Coker, 2022), need to be enhanced in order to improve the reading experiences of the dyslexic users. Lukes (2015) added that despite the abundance of reader applications available, none of them provide reluctant and struggling readers with a welcoming and warm reading experience. Challenges and distractions are significant factors that dyslexic students may face when utilizing game-based digital applications. Distractions can disrupt their focus and hinder task completion,

while personal and technological-related challenges hamper the reading development of the learners. It is crucial to acknowledge and address these challenges to create a supportive and engaging learning environment that minimizes distractions and provides targeted assistance to overcome specific difficulties encountered by dyslexic students.

Theme 3: Usability and Effectiveness of Instructional Applications

As part of the overall developmental process, it is common for designers to measure a design's usability—from idea to the final deliverable product—ensuring maximum usability (Chin et al., 2021). In this regard, dyslexic students' engagement and learning outcomes can be influenced by the usability and effectiveness of these game-based digital applications.

The usability level of the educational application generated by the process model was favorable (Arteaga & Rivera, 2018). With the use of Educational Applications, there were some improvements in the learning of students, particularly they overcome several learning difficulties (e.g., difficulty in identifying letters and its phoneme and grapheme, changing letters, & poor reading comprehension) arising from dyslexia (Arteaga & Rivera, 2018). The case study of Puradireja (2022), showed that the flashcard learning media method and the 'Learning Letters' application are effective for improving early reading skills for dyslexic children. The structure of the online courses and the easy accessibility of resources online received favorable rates and responses from the students; They thought the educational application was helpful (Arteaga & Rivera, 2018; Sekovanic et al., 2012; and Lukes, 2015). Several students also attributed their reading improvements to using the Dyslexia Friendly Reader App (Lukes, 2015). Finally, Elazab Elshazly (2016) and Lukes (2015) also found that using digital applications incorporated in tools (e.g., iPad, tablets) enhances dyslexic students' aptitudes and alleviates interruptions in the classroom which enables students to take part in conversations that are more in-depth.

The usability and effectiveness of instructional applications are critical factors that influence dyslexic students' engagement and learning outcomes. Creating usable applications with intuitive interfaces, structuring online courses effectively, and providing easy access to resources contribute to their effectiveness. Additionally, incorporating digital tools in the learning process, such as iPads, can alleviate disruptions and facilitate more meaningful interactions. By addressing the usability and effectiveness of instructional applications, the reading proficiency of dyslexic students can be enhanced and their learning journey supported.

Theme 4: Motivation and Academic Achievements

Motivation plays a crucial role in the engagement and success of dyslexic students when using game-based digital applications. According to the source of the motivation, researchers frequently distinguish between two types of motivation: extrinsic motivation refers to engaging in an activity in order to obtain a desired outcome apart from the activity, while intrinsic motivation occurs when no reward is received beyond engaging in a specific activity (Gooch et al., 2016). In this review, motivation may be incited by employing different strategies that elicit rewarding experiences such as extrinsic reward (giving badges) or intrinsic reward (feeling of enjoyment and learning).

The gamification application/platform ClassDojo, in the context of the case study, can foster student motivation because of an interaction between a pedagogically tailored appropriation by teachers and a highly customizable design (Gooch et al., 2016). Additionally, the use of customized badges for motivation leads to the reflection of students' own abilities and weaknesses (Gooch et al., 2016). The majority of the reviewed studies have concurred that the use of game-based digital applications is enjoyable and effective in supporting and improving the reading proficiency of DD students (Elazab Elshazly, 2016; Sekovanic et al., 2012; Puradireja, 2022; Borhan et al., 2018; Allafi et al., 2022; Russell, 2019; Barden, 2012; Skiada et al., 2014;

TEMAGOULT, 2020). It promotes collaboration and interaction in reading and writing because it allows for the exchange of ideas and the stimulation of the students' imaginations (Skiada et al., 2014). The results strongly suggested that the game-based mobile application had a good impact on dyslexic students' reading skills, greatly raising their reading levels (Allafi et al., 2022). These media and applications can make children feel enthusiastic, comfortable, and happy while learning and exploring their knowledge because they feel they can play (Puradireja (2022)

Overall, game-based digital applications are highly effective and helpful for dyslexic learners, not only in improving their reading skills but also their overall language capacity as well as their motivation to continue learning.

CONCLUSION AND RECOMMENDATIONS

Game-based digital applications have the potential to positively impact the reading proficiency of dyslexic students. However, it is essential to address the challenges and distractions that dyslexic students may face while using these applications to create a supportive and engaging learning environment that promotes inclusivity and academic success.

Based on the findings, the following recommendations are suggested: 1) educators and practitioners may consider incorporating game-based digital applications into dyslexic students' learning experiences to provide an interactive and engaging environment that supports the development of reading skills, word recognition, and phonological decoding abilities; 2) developers of instructional applications may prioritize the usability of their products to enhance the effectiveness of these applications and improve the learning experience for dyslexic students; 3) teachers may provide targeted support and interventions to specific difficulties associated with dyslexia to help students overcome these challenges and improve their reading abilities; 4) educators may leverage digital tools, such as the iPad, to create interactive and engaging learning environments for dyslexic students; and 5) implementing motivational strategies, such as the use of badges, and

recognizing and celebrating their accomplishments can boost their self-confidence and encourage them to persist in their learning journey.

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