

# The Role of Digital Books in Increasing Reading Motivation among Children with Dyslexia

Hutami Dwijayanti<sup>1,\*</sup>, Riama Maslan Sihombing<sup>2</sup>

<sup>1</sup> Bandung Institute of Technology, Indonesia

<sup>2</sup> Bandung Institute of Technology, Indonesia

\*Corresponding author. Email: [27120084@mahasiswa.itb.ac.id](mailto:27120084@mahasiswa.itb.ac.id)

## ABSTRACT

Becoming literate in reading and writing is one of the important basic skills young dyslexics do not easily acquire. Dyslexia is not related to intelligence; instead, dyslexics show disruptions in the rear reading system of the left hemisphere of their brain, which is critical for reading and writing skills. Research has shown that people with dyslexia also usually have lower reading motivation because of repeated experience of failures and social pressure around them. Roughly 10% of the young population in Indonesia have dyslexia, pushing the writers to analyze further about the possibility of developing technology in mobile applications to raise reading motivation among children with dyslexia. One such technology or mobile application is interactive digital picture books. The purpose of this literature review is to determine the kinds of visual elements and interactivity in digital books that appeal to children with dyslexia. The analyses here are done by narrative method: grouping data from past literature and research about digital books, reading motivation, and reading learning methods for dyslexics. Our literature review results show that certain visual elements and interactivity in digital books can increase reading motivation and are effective in teaching reading and writing to young dyslexics. For further research, we expect this literature review to be a foundation for digital book application development to teach, and motivate, reading and writing to young Indonesian dyslexics so they can improve their literacy skills.

**Keywords:** *Dyslexia, Digital Book, Education, Reading Motivation, User Experience*

## 1. INTRODUCTION

### 1.1. The Phenomenon of Reading Motivation Among Young Dyslexics

Dyslexia is as kind of learning disorder that happens to people with normal or even above-average intelligence. Dyslexics' learning difficulties result in and from a lack of such literacy skills as reading and writing. Also, social language issues can arise due to such a neurological disorder.

Dr. Kristiantini Dewi, Sp.A estimated that roughly 10% of children in Indonesia have dyslexia, with 80% of them having mild dyslexia, 15% having moderate dyslexia, and 5% severe dyslexia [1]. McDonald

Critchly, a former president of the World Federation of Neurology, found that dyslexia is the most common form of learning disorder where in one group of people with learning disorders, 80% of them have dyslexia [2].

Young dyslexics can still get accepted in regular schools because their disorder is out of sight, making their existence often unseen by others. This often creates a misunderstanding of them: mistakenly assuming low intelligence because of their repeated failures in learning reading and writing. This misunderstanding often causes dyslexics to lower their self-esteem and to lose motivation in acquiring literacy skills, especially reading.

### 1.2. Previous Research on Education Media for Dyslexics

Dyslexia cannot be cured, but literacy ability for people with dyslexia can still be nurtured based on remedial principles. That means if normal people need  $x$  hours, dyslexics need  $x^2$  hours when trying to grow their literacy skills. It's better for dyslexics to get intervention in their literacy skills since young before they reach 9 years old so they do not get left behind in school [1]. There are several learning methods that are proven to be effective in improving dyslexics' literacy. Two of the most popular learning methods that have been proven are the Fernald method and Orton Gillingham method. Both use V-A-K-T (Visual, Auditory, Kinetic, and Tactile) principle which employs a multisensory approach to learning. A neuroimaging research has proven that a multisensory approach can increase brain activity in terms of information processing compared to a single sensory approach because multisensory lessons can stimulate brain connections which leads to better retention and faster recall.<sup>1</sup>

Nowadays, improvements in digital technology are offering many opportunities in many fields of human life, including media in early childhood education. Forbes mentions several digital technology inventions that can be applied in education and learning: augmented reality/virtual reality, mixed reality, redesigned learning spaces (smartboards), artificial intelligence, learning personalization, and gamification. Interactive storybook mobile applications are one of the effective ways technology can be applied in education to improve literacy skills like reading. They can be easy to access and are also age-appropriate for young dyslexics. The interactive storybook applications will have the capability to stimulate multiple senses in terms of visual stimulation with animation feature, auditory stimulation by way of input and output sound features, and tactile stimulation [3].

### **1.3. Review Article Objective**

The phenomenon of many with dyslexia in Indonesia and the psychological impact in terms of low self-esteem and low reading motivation among dyslexics is an opportunity for digital books to be a potential education media, providing an effective intervention. In this review article, the writers plan to do further studies on dyslexic reading learning methods and motivation theory. The writers plan to analyze previous research studies on digital book potential in education media in terms of increasing reading motivation among young dyslexics.

## **2. YOUNG DYSLEXICS**

### **2.1. Impaired Cognitive Function in Dyslexics**

There is still not a wide range of research on dyslexia in Indonesia. Many people realize about their dyslexia after they have found their children diagnosed with it. Dyslexia in children is often diagnosed after they have started school or around 7 years old, but actually dyslexia can be detected when they were younger to get intervention early.<sup>1</sup> Some characteristics you can find in children with dyslexia are: they have short-term memory; have a hard time understanding time and space concepts; lack sequencing skills; may also reverse the order of two letters especially when there are words that look similar to the intended word like 'mat', 'cat', and 'nap'; commit letter addition/subtraction; develop a social disorder; and can also develop other disorders like ADHD and bad fine motoric skills.<sup>4</sup>

People with dyslexia have normal or high intelligence, but they have a neurological problem in their brain stem due to genetic factors, brain injury, or phonological processing factor) [4]. The human brain consists of two hemispheres, right and left where each of the hemisphere has different functions in processing information. The left brain hemisphere processes language and information, meanwhile the right brain hemisphere processes information that involves holistic perspectives like picture and other visual-based information<sup>1</sup>.

Research has shown that the right brain hemisphere of people with dyslexia has a higher capability than their left hemisphere, causing difficulty in processing language, but they can still have a good understanding of the context. Because of the higher capability of their right hemisphere, people with dyslexia usually have a preference for thinking visually rather than verbally and distinctive perceptual [5]. For an ideal language ability, people need to have a balance between both brain hemispheres.

### **2.2. Psychological Impact Faced by People with Dyslexia**

Dyslexia in children, if not treated properly and early enough, can cause secondary problems in behavior like disobedience, argumentative behavior, anxiety, and depression. Therefore, the most important thing is to handle the primary problems, which is dyslexia itself. The earlier dyslexia gets treated, the less likely secondary problems can occur. For example, when a child is not doing well in school, their parents can scold the child or even accuse the child of being lazy because they don't know that their child may have dyslexia. It can cause low confidence, creating a negative self-image which leads to an unhealthy emotional development [4].

Shianne and Karina, children psychologists, mention that every person with dyslexia has different difficulties in developing their literacy skills in reading, writing, and spelling. The most common difficulty they found in

young dyslexics is in terms of their psychology; the affected child can give up on honing their literacy skills because of psychological pressure both from external factors like their external support systems and internal factors like feeling left behind by their peers or feeling that their literacy skills have not improved even after putting in so much effort.

Ferrer & Soriano’s research, among 68 kids consisting of two different groups of 33 children with dyslexia and of 35 kids with normal literacy skills, found that children with dyslexia have low motivation and disinterest in reading compared to children with normal literacy skills. Ferrer concluded that motivation in young dyslexics is related to self-determination theory; those children gave up because of repeated failures while learning reading, make them shun reading activities [6]. Shianne also mentions that by appreciating or praising these children for any achievement made, their motivation increases. By making them feel acknowledged, they build more confidence, and when they have more confidence, they are motivated to learn.

**2.3. SDT Theory**

Self-Determination Theory (SDT) is a motivation theory that was first introduced by Edward L. Deci and Richard M. Ryan in 1984. This theory focuses on the individual’s internal factors in achieving their self-confidence and self-actualization. SDT postulates that for a person to get motivated and self-determined, they need to know that what they are doing can positively impact their self-growth and that of other people. SDT can be applied in many life circumstances, including education, work, raising children, and health [7].

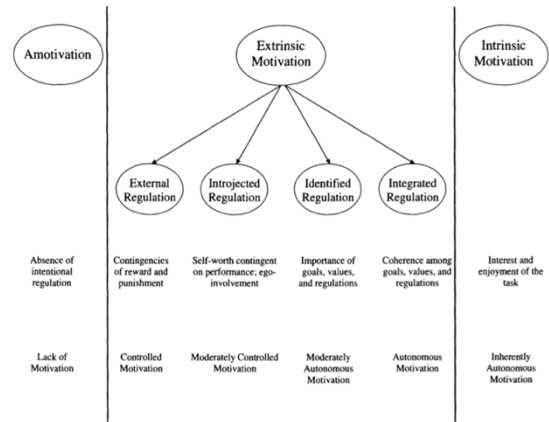
According to Deci and Ryan, there are three basic intrinsic needs that need to be fulfilled to achieve self-determination:

1. **Autonomy** : the feeling of freedom in a person, who is able to do things ‘freely’, that comes internally from within themselves
2. **Relationship** : the feeling of acceptance and of a delightful social relationship experience in their community/social circumstances
3. **Competency** : the sense of confidence in their capability to do something well

There are three kinds of intrinsic motivation based on SDT:

1. Intrinsic motivation related to knowledge
2. Intrinsic motivation related to accomplishment
3. Intrinsic motivation related to stimulation of doing something

**Table 1.** SDT Continuum table, describing type of motivation



**2.4. Fernald Theory**

The Fernald method is a learning method based on a multisensory (Visual-Auditory-Kinesthetic-Tactile) approach. This method was introduced by Grace Fernald in 1921, an education psychologist. This method has been proven in increasing sight-words and word identification in children who failed to learn reading with any other method or who have specific difficulties learning certain kinds of words.<sup>4</sup>

By using the Fernald method, children with dyslexia can improve and memorize words they have learned. The Fernald method contains four steps in literacy skills learning:

1. Teacher/Mentor lets the child pick the word they want to learn
2. Teacher writes the word on paper (4in x 10in) and spells the word
3. The kid traces the word with their hand, spells it repeatedly, and then copies the writing while spelling the word repeatedly
4. The kid writes the word out from memory after they are able to write it, then proceeds to the next word until all the words can be arranged into a story [8].

**3. THE ROLE OF DIGITAL BOOKS IN INCREASING READING MOTIVATION**

**3.1. Digital Picture Books in Indonesia**

In line with the current technological development, digital books have increasingly become an opportunity to

provide an informal education to children. Based on data by Keminfo in 2017, around 65% of Indonesians aged 9 to 19 actively use smartphones with the highest adoption occurring in Sumatra and Java. By 2025, an estimated 89% of Indonesians will use smartphones. Survey data obtained by The Asian Parent Insight in 2014 on 2500 parents in Singapore, Thailand, Indonesia, Malaysia, and the Philippines showed that 41% of children had spent 1 hour per day actively using their smartphones. The survey also found that 80% of parents allowed their children screen time for educational purposes and 57% of parents allowed their children to use smartphones for education. Such data indicate smartphones can potentially become the media that helps improve literacy in children.

In terms of picture books, children were sophisticated readers of visual texts, they able to understand different viewpoints, analyse moods, messages and emotions, and articulate personal responses to picturebooks even when they struggled with the written word [9]. Digital picture books are more advantageous compared to traditional or printed books. Hana Satriyo from The Asia Foundation Indonesia says that digital picture books are a consequence of the current technological innovation that positively impacts production, distribution, and literacy access. Digital picture books also offer yet another advantage in providing an experience that is interactive and more engaging compared to printed picture books [10].

### **3.2. The Interactivity of Digital Books**

An advantage of digital books lies in their stimulation of multisensory interaction compared to traditional books. Gestures and interactions on mobile smartphone applications can be divided into seven types: pinch, tap, scroll and pan, swipe, rotate, drag and long press. These gestures and interactions that can be implemented in interactive digital books are:

1. Pinch gesture : for example, to make an application's content smaller or bigger
2. Tap gesture : for example, to use a dropdown menu, select a listening button to read aloud, or move objects on illustrated digital books
3. Scroll gesture : to move a content's page up and down
4. Swipe gesture: to change pages using the left/right swipe or up/down swipe, and to trace when learning the alphabets
5. Rotate gesture: to spin or rotate objects like in alphabet puzzle games
6. Drag gesture : to move objects like in alphabet puzzle games

Natalia Kucirkova, in her research, demonstrated that digital book features can focus on two main mechanisms to support children when they learn using digital books: hotspot that can move words when touched and hotspot that can move illustrations. Verhallen & Bus studied, in 2010, 92 immigrant children aged 5 in the Netherlands reading digital books with moving pictures and without. The study found that children who had read digital books with moving pictures could learn words better than those who had read the same digital books without moving pictures. The hypothesis is: moving pictures can help children associate text with the accompanying pictures. This means the pictures used should be consistent with the text for the same story [1q].

Another study by Erik Thiessen from Carnegie Mellon University evaluated the memory capability of 30 children aged 3-5 after being given static story books or interactive story books filled with animation on each page. The result: the children who read the interactive story books filled with animation on each page recalled 15 to 20% more than the children who read the static story books [12].

## **4. DISCUSSION**

The writers will analyze several research studies to develop a digital book for dyslexics. Among the studies to be considered are Roxan, Evai, Anna, and Dimitrios who developed Easylexia; Jorge, Catarina, Luís, and Paula who developed an application to help dyslexics; and Rabbia and Seemab who developed a mobile application for dyslexics who face writing difficulties.

Roxan, Evai, Anna, and Dimitrios developed Easylexia in 2014 to provide the stimulation and experience for children that can support their learning. They studied the usability of their application that can positively influence or benefit children. Easylexia is an interactive digital book application that consists of four basic categories: words, numbers, memory practices, and books that are gamified. The application uses a scoring system in its gamification as an external motivator to raise self-confidence and motivation to reach the different goals in the application. In addition, the fonts used are suitable for dyslexics to allow for an easy use of the application. Different from the first three categories which are meant to improve literacy, the books category is also for widening knowledge, increasing engagement, improving vocabulary, improving spelling, and encouraging imagination. The stories in the books category are stories appropriate for children aged 7-12 with illustrations describing the text, limited use of words/text, big margins, and features for parents to gauge the stories their children like and to receive daily usage and score reports.

An evaluation was then conducted to compare two instruments, digital books and conventional books, which were given to five dyslexic children and to a control group of five children who do not have learning difficulties. Such a study was to evaluate if learning preferences are influenced by dyslexia or other factors. The results showed that all the children preferred digital books and that digital books could make the dyslexic group stay focused, not distracted, on their device's screen. Besides, the children still continued using the application even after the evaluator had left, demonstrating that digital media for education is promising in terms of attention span [13]. The journal on Easylexia is arranged in detail, providing conceptual information, development process, and evaluation results. However, the journal does not publish on the books category that was developed too and does not cover the increase in children's literacy interest in using other medias after they have used Easylexia.



Fig.1 "Word Finder" game layout from level one



Fig.2. Words category, "choose if" g



Fig.3. "Numbers" game layout from level one

**Figure 1.** Easylexia mobile application develop by Roxan, Evai, Anna, and Dimitrios

**Table 2.** Evaluation on Easylexia Mobile Application

	1st User	2nd User	3rd User	4th User	5th User
Age (years old)	12	11	10	7	10
Gender	Girl	Boy	Boy	Boy	Boy
Dyslexia Categorization (the level of severity of the user's difficulties)	Mild	Severe	Moderate	Moderate	Moderate
Period of specialized intervention and treatment	12months ago	12months ago	12months ago	18months ago	12months
Time to complete a level	3-30 sec	50-55sec	18 sec -1min	30-60 sec	30-60 sec
Errors (made by game)	0	4	1	2-3	2-3
Clarifications needed	No	Yes	No	Yes	Yes
Found the app intriguing	Yes	Yes	Yes	Yes	Yes

Jorge, Catarina, Luís, and Paula also developed an application to help dyslexics by analyzing possible solutions and proposing a mobile application prototype that dyslexics can use. The researchers and developers collected input from dyslexics and their teachers. The prototype focused on Portuguese language where the research subjects were students aged 10-12. The prototype developed was a digital activity book that can reteach children aged 10-12 who were left behind in literacy skills [14].

The activities in this Android-based prototype included gamification in four activity categories: completing the first word, poetry, alphabet sequence in

words, and structures of syllables. Each activity consisted of five levels where the difficulty level would adjust to the user's performance, and a score of +1 was awarded for a right answer while -1 was given for a wrong answer. The developers also considered the element of self-confidence among dyslexics by minimalizing the number of wrong answers through allowing opportunities for the user to obtain a right answer, so the user did not give up. After using or playing, the results were kept in the system, so the teacher or parent could monitor the user's progress. Among the data kept in the system were words chosen, time taken to answer, average time taken from one tap to another, time taken for each tap, and score obtained. The evaluation conducted on the two groups was the same as the Easylexia research. However, each group consisted of four children. The results showed that the two groups produced approximately the same average time where alphabet sequence and word structure were the two lowest performing categories probably because the dyslexic group have started an adequate early intervention. There was a big difference in time for completing the first word category between the two groups; the dyslexic group had more difficulty in identifying the sequence of alphabets involving 'est' while the control group had more difficulty in identifying words involving the syllable 'ma'. Preliminary results showed that gamification can provide opportunities for dyslexics to develop their multisensory perception, a value added for adaptation and learning [13]. This research journal does not cover the impact of digital application on reading motivation in dyslexics. Nevertheless, this research can be an inspiration for a solution for dyslexics to acquire literacy skills at the same level as those who do not have any learning disorder.



**Figure 2.** Mobile application interface develop by Jorge, Catarina, Luís, and Paula

**Table 3.** Evaluation Between 2 Groups Consist of Dyslexia (D) and Control Group (CG)

	Beginning		Rhymes		Sequences		Syllabic	
	D	CG	D	CG	D	CG	D	CG
Time (sec) - Average	36	45	37	40	64	61	49	56
Time (sec) - Standard Deviation	8	20	16	16	23	27	18	25
Time (sec) - Minimum	25	23	19	16	32	27	15	22
Time (sec) - Maximum	48	97	74	75	103	96	67	98
Score - Average	16	16	14	15	12	9	8	8
Score - Standard Deviation	3	1	3	3	5	5	4	3
Score percentage - Average	94%	94%	82%	88%	71%	53%	47%	47%
Score - Minimum	8	14	7	6	5	2	3	2
Score - Maximum	17	17	17	17	17	17	13	13

Rabbia and Seemab, in a journal published in 2016, described a research on a planned mobile application, Writers Learning Algorithm (WLA), to increase the performance of dyslexics who face writing difficulties based on a learning model that is fundamentally computational. The analysis on the planned usability was conducted by distributing a questionnaire to therapists who see dyslexics and to parents who have dyslexic children aged 5 and below. The questionnaire was divided into three sections in the user interface. The content and evaluation from the questionnaire showed that convenience of user interface is the most important element in application development. The application developed was a digital activity book that teaches alphabet writing where its implementation mechanism involves repetitive learning. The purpose of this mechanism is so the user can repeat the same alphabet character set to the point of complete success. This WLA application displays each character set that has to be recognized, memorized, repeated, and written by the user. The available characters are divided into three types: alphabets, numbers, and symbols. The number of characters differs from one session to the next where the system determines the character set. An evaluation was done to decide whether the user could proceed to the next session or had to restart a session while still ensuring activity went on. The application is also designed to increase external motivation of the user by showing the user's progress, achievement ratings and their percentages, and by showing the time taken to complete an activity. Preliminary results proved the role of digital application in representation/presentation, evaluation, and optimization of writing skills among dyslexic children [14]. This research journal describes in detail the analytical processes from development to roll-out and the analyses of the intervention impact on the users' writing skills. However, it does not discuss the possibility of a positive impact by such intervention on the research subjects' reading skills.

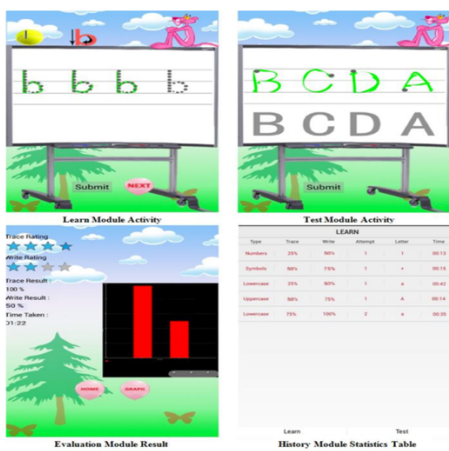


Figure 3. Writers Learning Algorithm (WLA) interface develop by Rabbia, and Seemab

The writers summarize these three research studies' results on the planning of a digital book application for dyslexics:

1. All three employ a multisensory approach (V-A-K-T) with attention to user interface and content that is aligned to the needs and psychology of dyslexic children
2. The three evaluations reveal an increase in the literacy skills of the research subjects and the potential for developing further digital books as an educational media for dyslexic children
3. From the three digital books for dyslexics developed by the authors/researchers, the writers found similarities in terms of external motivation and internal motivation. The external motivation includes gamification by way of awarding scores and producing evaluation results about the user. The internal motivation includes features or actions that increase self-confidence in the user's competence or efficacy. This matter is also in line with Ferrer and Soriano's research conclusion, which states that motivation among dyslexic children is related to the theory of self-determination, which originates from internal motivation.

## 5. SUMMARY

The main objective of this review article is to explore further the role of digital books in increasing reading motivation among children with dyslexia. The analyses and results show that digital books have immense potential for increasing external and internal motivation while befitting dyslexic children. Children have been proven to be able to focus longer when using digital books compared to print media. Furthermore, they have demonstrated an increased engagement in using digital applications continually, thereby increasing their literacy. Yet such visual appearance aspects as shape, size, and alphabet colour plus their animation are central to the development of digital book applications. Unimportant or unnecessary animated words or pictures can distract and reduce the efficacy of digital book applications among children, especially dyslexic children. All told, most research studies so far have only provided detailed evaluations on the development of literacy skills more than on increasing reading motivation among dyslexic children. In the future writers can research furthermore about the impact on applying SDP motivation theory in digital book for children.

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