

## MULTI-SENSORY APPROACH IN DESIGNING AUGMENTED LEARNING KIT FOR CHILDREN WITH DYSLEXIA

Fonita Theresia Yoliando

Received October. 10, 2022; Revised November. 18, 2022; Accepted December. 07, 2022.

**Abstract:** *The human brain is a complex structure that allows us to encode and decode various stimuli that incorporate the five senses. In the case of children with dyslexia, this information processing performs inefficiently which resulted in reading, spelling, and/ or writing difficulties. Other related difficulties, such as memorizing, organizing, sequencing, and motor skills deficiency, may also be present. This specific learning difference is a lifetime challenge that cannot be cured, but it can be overcome through structured interventions. For many years, the multi-sensory approach utilized visual, auditory, and kinesthetic-tactile to trigger the senses, which is well known as one of the most compelling aspects of instruction for dyslexic students. By simultaneously training the brain through the senses, it is hypothesized that this approach can enhance the phonetical ability in a more effective and meaningful way through the implementation of an interactive learning kit for dyslexia. This paper is an initial phase of long-term research about an interactive learning kit for dyslexia. It includes the analysis of a multi-sensory approach and how it can be implemented in the design and development process in the next phase.*

**Keywords:** *dyslexia; multi-sensory; interactive; learning.*

### Introduction

Dyslexia is a spectrum of learning difficulties caused by information processing issues in the brain or the senses by challenges in several phonetic aspects (Oga, 2012). According to Loftus (2009), there are several categories of difficulties experienced by children with dyslexia, such as memory (recalling facts or formulas), reading (inefficient and slow comprehension), writing (incorrect letter structure and poor handwriting skills), spelling (mispronunciation and inconsistent speech), direction (visual-spatial perception), and organization (schedules, deadlines, and order).

Based on past research by Hermijanto (2016), dyslexia affects around 10%

of the world's population which grows significantly as a national and international concern. This was also confirmed by Dyslexia Center Indonesia founder, Dr. Eng. Sumarsono, ST., MT., OCP that 1 out of 5 people in Indonesia encounter language-based learning difficulties and dyslexia is the most common one among them. Most of them are undiagnosed and untreated properly. Around 50% of those people are believed to sustain visual-perceptual distortion which is also termed as Meares-Irlen Syndrome (Stein, 2012). Its unique symptoms tend to worsen the indication that is already faced by people with dyslexia as they perceive the words as doubled, overlapped, faded, shaken, bounced, swirled, and moved irregularly.

Fonita Theresia Yoliando is a lecturer at The Faculty of Art and Design Universitas Multimedia Nusantara (UMN).

e-mail: [fonita.yoliando@umn.ac.id](mailto:fonita.yoliando@umn.ac.id)

As dyslexia is a large spectrum learning difficulty, each individual most probably exhibits different symptoms and has a distinctive way to overcome them. Though these challenges have a great possibility to persist into adolescence, adulthood, and even a lifetime, a previous study claimed that dyslexia is not linked with intelligence (Oga, 2012). Most of them are at least average or above the average IQ level and possessed strong vision in creative work, storytelling, and problem-solving. Nevertheless, if their challenges are not surmounted properly, they will not be able to adapt and perform well academically and socially. In this case, the learning environment and the method of intervention are highly substantial in supporting people with dyslexia.

According to that background, this research aims to be the first step of full research about learning kits for children with dyslexia. Therefore, this research seeks to answer the following question:

1. How to analyze and implement a multi-sensory approach to improve phonemic awareness of children with dyslexia?
2. How to incorporate storytelling and augmented reality to enhance the interactivity level and fun aspects of developing a learning kit for dyslexia?

## Methodology

Based on the research questions mentioned above, a sequential exploratory design method was implemented (Creswell, 2014). In this first phase, a qualitative method was conducted as the key basis to examine the hypothesis and implement the multi-sensory approach, storytelling, and augmented reality in a learning kit for dyslexia to answer the research questions. In collecting all data needed, two in-depth interviews were performed with an educational therapist from a dyslexia association

and an English educator who is also a parent with a child with dyslexia. These interviews as an initial step of this research were performed between March to May 2022 then continued with the design and development process from June to October 2022. In the next phase of research, the multi-sensory learning kit should be examined in detail through quantitative method to measure the impact resulted to the learning improvement of children with dyslexia.

The rationale for using qualitative method in the first phase of research is because dyslexia is still understudied and can be considered an unseen phenomenon in Indonesia. Most of the people with dyslexia are undiagnosed and labeled as simply lazy, inattentive, and lack of motivation which resulted in skepticism and disgrace. In this regard, the questionnaire is considered less ineffective as the awareness level in Indonesia is still concerning and there is low probability to find children who are affected by dyslexia.

### 1. Dyslexia Center Indonesia

The initial interview was addressed to Dyslexia Center Indonesia's founder, Dr. Eng. Sumarsono, S. T., M.T., OCP who is also a registered educational therapist in Pearson Clinical Education (US and UK) and RETA (Singapore). This interview aims to gain a deeper understanding of the research on dyslexia in Indonesia, recommended assessment and learning methods, also learning difficulties that are faced by people with dyslexia, especially in reading, spelling, and writing.

Based on the method applied in DCI, there are five steps performed on people with dyslexia: screening, assessment, consultation, intervention and monitoring. In many cases, dyslexia overlaps with many other disabilities, such as dysgraphia, dyscalculia, ADHD, autism, and others. Therefore, most of them are often undiagnosed as dyslexia is not well termed

in Indonesia. The ideal period to perform the assessment is around 5-7 years old as the distinct symptoms are now evident and can be verified easier through their performance in school. In this case, the most ideal period of intervention is 5-7 years old which then will be the target user of the resulted multi-sensory learning kit.

One of the most common myths states that dyslexia is a character issue or a visual problem. It was then argued by Sumarsono that people with dyslexia were just desperate to be able to read and write which resulted in a rebellious tendency. Aside from that, he also mentioned that visual and auditory problems cannot be separated in a dyslexia case. The source of the dyslexia problem is in the brain so it cannot be solved easily by using colored lenses or vision therapy, though it helps them in reducing the distortion. In this case, based on his experience in Dyslexia Center Indonesia, a multi-sensory approach that focuses on visual and auditory is agreed to be an effective method to assist people with dyslexia in learning, reading, writing, and spelling.

As dyslexia is a lifetime challenge, there is no cure and just an intervention method that can support them in the learning process. There are many kinds of helping tools in the market, starting from colored glasses, rulers, special fonts for dyslexia, training books, digital games, and others. However, dyslexia is a spectrum that exhibits different symptoms from one to another so the helping tools should also be evaluated, adjusted, and improved from time to time to cover the variety of dyslexic's needs. On the other hand, the cost of those helping tools is also relatively high so not everyone can afford that. In conclusion, an improved learning kit that covered visual and auditory learning processes and is accessible to people from any background should be researched, developed, and disseminated to the public.

## 2. English Educator & Parent

The next interview was conducted with Riana as the representative of dyslexia parents and also an English educator. Firstly, there was an explanation about the experience as a parent with a dyslexic child. She stated that it was challenging to teach her child in primary school as he could not blend in with his friends and tended to be underperformed in school. It was also told that the child often got curious over some small specific things but could not comprehend the meaning of simple words that were perceived as uninteresting for him. In this case, Riana focused on his favorite topic and made him engage in the story to improve phonemic awareness. Through empathy and engagement, the child was able to understand and comprehend the meaning of words relatively easier.

On the other hand, as an English educator, she also suggested assisting children with dyslexia in learning the alphabet and then the meaning of the word. In contrast with Bahasa, syllables are not substantial in English so the learning process just started with alphabets and then jumped to words. This is the result of the various phoneme in English which resulted in various speech sounds. To conclude, there were two key points: storytelling and phoneme, that should be taken into consideration in the designing and developing process of this learning kit.

## Multi-sensory Approach

Past studies by Loftus (2009) argued that people with dyslexia have high abilities to see patterns in each piece of information visually and holistically. In this regard, plenty of researchers also raised the potential of a multi-sensory approach for children with dyslexia to utilize all possible pathways in the brain, especially visual, auditory, and tactile. This multi-sense

training is presumed to simultaneously improve phonetic perception and specify phonemic representations, especially shape, sound, and structure of alphabet and word in reading, writing, and spelling.

This is also supported by Obaid's (2013) and Kamala's research (2014) which explain the significant improvement in students' spelling and reading skills which resulted from the implementation of multi-sensory media for learning disabilities, including dyslexia. Similar research patented by Smith (2013) also proved that multisensory can be utilized in assisting students with dyslexia to polish their reading skills in English.

Besides reading, writing, and spelling skills, comprehension ability is the most essential in linguistic understanding. There is no point if they can distinguish each shape, sound, and structure of each word but they cannot incorporate the meaning and practice them in their lives. Based on the interview with a parent of a child with dyslexia, the most challenging difficulty of dyslexia is the way their brains comprehend words differently as they are not able to link the shape and sound of the word to the meaning of the word itself, especially if they cannot empathize with the meaning of a word.

Table 1. Multi-sensory Approach for Dyslexia (Source: Personal research documentation)

Skills	V	A	T
Reading	vvv	vv	v
Writing	vv	v	vvv
Spelling	v	vvv	vv
Comprehension	Storytelling		

V : Visual    A : Audio    T : Tactile

In this case, it is suggested by parents and experts in the dyslexia association to take advantage of storytelling in explaining the meaning of a word to people with dyslexia. Related to their main virtue in

the creative field, visual storytelling is hypothesized as an effective method to make people with dyslexia to be able to visualize words more straightforwardly to increase their comprehension.

### Augmented Reality

Based on Peddie (2017), Augmented reality (AR) is defined as a real-time projection of direct/ indirect virtual information which is generated through a device program to the real world to create rightful depth perception and a precise spatial arrangement. In this era, augmented reality doesn't just impose 2D or 3D visualization but also audio and direct interaction with the user through 2 main steps: tracking (locating and mapping) and rendering (scaling and projecting) as can be seen below in Figure 1.

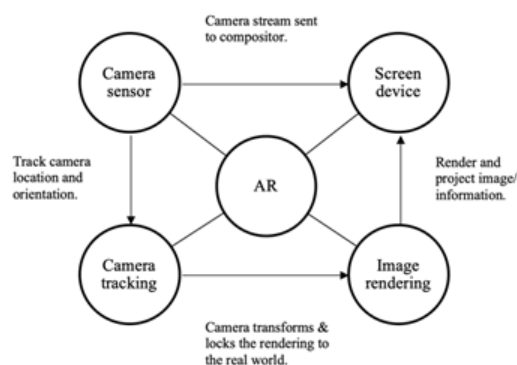


Figure 1. Augmented Reality Process (Source: Peddie, 2017)

In AR, a device provides additional visual information as a transparent object on the screen so users can see both the real visualization and the rendered visualization. As a result, there aren't side effects such as visual distortion or motion sickness compared to virtual reality. Moreover, the user can experience augmented reality through their smartphone through a website or application. Considering these benefits gained from



augmented reality, this research tried to implement augmented reality to stimulate visual, auditory, and tactile senses in the learning process so this learning kit can be advantageous to children and parents from any background.

On the other hand, storytelling also added to the learning process to intrigue the level of curiosity and engagement of the users which are children with dyslexia. This is also aligned with the interview result with Riana as an English educator and also a parent of a child with dyslexia which stated that the implementation of storytelling in connecting the shape and sound of a word to the meaning of a word is undoubtedly essential. In this regard, storytelling can be embedded in the design to make the child empathize more with the word which resulted in a long-term remembrance and deeper comprehension level.

## Result

Based on the mentioned hypothesis, the objective of this research is to implement visual storytelling in multi-sensory flash cards equipped with augmented reality to support children with dyslexia to read, write, and spell 26 alphabets and their related words. All cards are sized 5 x 6.5 cm and two-sided, the front side is the alphabet and the back side consists of 4 words that are associated with the pointed alphabet. In designing the flashcards, there are several considerations need to be adjusted to ensure they are suitable for children with dyslexia and can support the learning process in a meaningful way:

### 1. Color

Based on the BDA Dyslexia Guide 2018 and the comparative study done by Yoliando (2020), highly contrasting colors should be avoided, and warm pastel colors such as peach, cream, and orange could significantly improve the reading speed

of people with dyslexia as seen in Figure 2. In this regard, the usage of pure white as the usual background color was then replaced with broken white/ cream. The paper material was also matte enough to avoid any reflective effects as they tend to distress dyslexia's reading experience (Rello, 2012).



Figure 2. Color Palette for Dyslexia  
(Source: Personal research documentation)

### 2. Typography

Referring to a past study by Rello, Pielot, & Marcos (2016), the most prominent factors which led to quick reading speed, short fixation time, and more precise spelling were the font size and font type. It was suggested to use as largest font size possible and avoid using less than 12 pt for the body text. Moreover, all alphabet and words were also presented in lowercase and regular (no italic/ bold) with wide spacing between lines and alphabets to avoid any further confusion. Any effects, such as drop shadow, bevel, and gradient were also averted.

Aside from that, it was recommended to use Comic Sans, Arial, and other sans-serif fonts. In this case, the flashcards used Quicksand Regular which is a sans-serif font but hasn't yet been observed by other studies. Quicksand as seen in Figure 3, also has a unique letter 'a' which is similar to handwriting and also shows mirroring features among 'i', 'l', 'j', 't', 'b', and 'd' which is presumed as difficult to be distinguished by people with dyslexia. The other aim of this research is also to prove this claim. To ease the reading experience, there are also thin horizontal lines as the guidance grid to help the children with dyslexia to read and copy the alphabet.

abcdefghijklmnopqrstuvwxy

Figure 3. Font Type Quicksand  
(Source: Personal research documentation)

### 3. Flashcards

According to the considerations above, the design of the flashcards was finalized. The 26 alphabets then categorized based on the structural similarity in 11 color codes. The reasoning behind this categorization is to emphasize the difficulty which is faced by children with dyslexia when encountering two similarly shaped alphabets. By grouping these similar alphabets, parents can emphasize each category and repeat them intensely so the children can remember them easier in a long term. The details of the alphabet categorization can be seen in the Table 2 below.

Table 2. Flashcards Grouping  
(Source: Personal research documentation)

Group	Alphabet			
1	a	o		
2	b	d		
3	c	e		
4	f	t		
5	g	y		
6	h	k		
7	i	l	j	r
8	m	n		
9	p	q		
10	s	z		
11	u	v	w	x

The 26 alphabet cards were designed to emphasize the multisensory approach and storytelling of each word consisted in the alphabet card. The layout was arranged to be as simple as possible to avoid distractive background, while the illustration used an outline to make the object distinguishable significantly.

On the front side of the card, the visu-

al, auditory, and tactile were stimulated. For the visual, there are thin horizontal lines as the grid of the alphabet to help children with dyslexia to see them more comfortably as they face difficulties in seeing letters in line. Moreover, there was a specific pattern that aimed to trigger particular audio or project-specific imagery in the augmented application which can be accessed through mobile device. The shape of the alphabet can also be sensed through the spot-UV finishing touch in the printing process.

On the contrary, on the back side of the card, the focus is placed on the word learning. There is a conceptual illustration that can be used by the parents to tell the freestyle storytelling to make the words more engaging for the children. In addition, there is also an AR feature that triggers four related words to represent each alphabet. All of the cards are equipped with sound to vocalize each alphabet and word. In this regard, all of the features are implemented to support multisensory approach in order to enhance the learning experience of children with dyslexia in the long term.

Table 3. Multi-sensory Flashcards  
(Source: Personal research documentation)

Front - Alphabet	Back - Word
Letter shape	Illustration
AR letter sound	AR pop up text
AR letter tracing	AR word sound

The augmented reality was applied using the projection mapping method to visualize and render the specific words on the illustration. The words chosen are at maximum consist of 6 alphabets to adjust the difficulty level to suit 5-7 years old children. Through the three senses stimulus as explained in the table above, the AR then can trigger not just visuals, but also the sound of the alphabet and words. On the illustration visualized on the back side

of the alphabet card, there is storytelling embedded to facilitate parents to explain the meaning of each alphabet card and its related words. For example, in Figure 4 below, there are 4 words described: hat, hand, horse, and house. Instead of illustrating each object separately, a single illustration is used so the parents can freely create a freestyle story, such as The Ranch Owner and His Beautiful Horse.



Figure 4. Flashcard Design AR  
(Source: Personal research documentation)

On the front side of the alphabet card, there is also a play button, where users can learn to trace the alphabet on their device. This feature was implemented to enhance the tactile sense of the users and also improve their ability to print and write. Moreover, the card will also be printed using the spot-UV finishing so they can physically feel the alphabet's shape.

The overall feature of the AR flashcards is currently still undergoing the Alpha Test for children 5-7 years old in general and the Beta Test to dyslexia children with the help of dyslexia association in Indonesia and Malaysia in the next phase

of this research. The testing will utilize quantitative method to measure the concrete impact of recalling ability, learning duration, and enjoyment level of users in a long term.



Figure 5: Flashcard Design Tracing  
(Source: Personal research documentation)

## Discussion

Throughout this research, there are several findings that will be a notable consideration in the next phase of the research. Firstly, the multi-sensory approach scientifically plays a major role in the learning process, especially for dyslexia. The implementation of storytelling and augmented reality is also hypothesized to be beneficial to raise phonemic awareness of children with dyslexia. Though all of these key points are well carried out in the learning kit, the result still needs to be processed, discussed, and evaluated conscientiously. Therefore, the result of this research can be addressed as the ensuing learning method of dyslexia which not just utilize the conventional way of multi-sensory approach, but also employ storytelling and augmented reality at the same time.

As dyslexia is not equally perceived in Indonesia compared to US and UK countries, there are limited resources and studies to support this research. There were also several shifted variables along

the process caused by the different stand-points from several past research compared to the current suggestions. Those differences could be a beneficial factor that enriches the product or an unfavorable factor depending on the execution of this research.

To ensure that this learning kit is accessible for people with dyslexia from any background, there are also some adjustments needed, especially in the distribution and publication strategy in the near future through collaboration with Gains Education, which is an educational foundation based in Malaysia and also Dyslexia Center Indonesia as a specialist educator in dyslexia and plays a key role to verify the validity of the learning contents. This execution aims to disseminate the benefits of this learning kit to as many people as possible in any country, especially Indonesia and Malaysia.

## Conclusion

A multisensory approach is widely believed to elevate the motivation and support the learning process of children with dyslexia. Therefore, it may not apply to every child in any country as the way they perceive language is comparatively different from one another. The consensus is that the utilization of creative and interactive methods can be beneficial as long as it is adapted to the subjects, objectives, contexts, and situations of each child. In this regard, the practice of a multi-sensory approach should still be explored from time to time and improved along with the rapid changes in technology and education.

As this research is the initial phase of a long-term project with real industry involvement, which is Gains Education and Dyslexia Center Indonesia, there are still plenty of adjustments and evaluations that need to be performed before moving forward to the production, publication,

and distribution phase. The result from this analytical paper then should be examined further to collect quantitative and also qualitative measurements of the improvement in reading, writing, and spelling skills of 5-7 years-old children with dyslexia, impacted by multi-sensory learning kit which covered visual, auditory, and tactile experience through storytelling and augmented reality.

## References

- British Dyslexia Association. (2018). *Dyslexia style guide*. Retrieved from [www.bdadyslexia.org.uk](http://www.bdadyslexia.org.uk) (Accessed 22 August 2020).
- Kamala, R. (2014). "Multi-sensory approach to reading skills of dyslexic students". *IOSR Journal of Humanities and Social Science*, 19 (5), 32-34.
- Loftus, T. (2009). *Supporting students with dyslexia: practical guidelines for institutions of further and higher education*. Dublin: Ahead Educational Press.
- Martin, B. & Hanington, B. (2012). *Universal methods of design*. MA: Rockport Publishers.
- Magnan, A., Ecalle, J., & Gombert, J. (2006). "Audio-visual training in the discrimination of the phonetic feature of voicing in dyslexic children". *Dyslexia in Children: New Research*, 47-64.
- Obaid, M.A.S. (2013). "The impact of using the multi-sensory approach for teaching students with learning disabilities". *Journal of International Education Research (JIER)*, 9 (1), 75-82.
- Oga, C. & Haron, F. (2012). "Life experiences of individuals living with dyslexia in Malaysia: A phenomenal study". *Procedia – Social & Behavior-*



- al Science, 46, 1129-1133.
- Peddie, J. (2017). *Augmented reality*. Switzerland: Springer.
- Puspitaloka, N., Syarif, H., & Ermanto. (2020). "Teacher's perception on how multisensory approach in teaching reading for EYL with dyslexia". *The International Conference on Language and Arts*, 179-183.
- Rello, L. (2012). "Optimal colors to improve readability for people with dyslexia". *Text Customization for Readability Online Symposium*. Barcelona: W3C.
- Rello, L., Pielot, M., & Marcos, M. (2016). "Make it big! The effect of font size and line spacing on online readability". In *PNAS (2012). Journals of PNAS July 10, 2016, 109 (28)*, pp. 11455-11459. <http://dx.doi.org/10.1145/2858036.2858204>
- Singh, S. M. & Manzura, E. (2010). "A multisensory multimedia model to support dyslexic children in learning". *The International Conference on Signal Processing and Multimedia Applications*, 193-202.
- Smith, A. (2013). U.S. Patent Application No. 13/848,190.
- Stein, J. & Kapoula, Z. (2012). *Visual aspects of dyslexia*. London: Oxford University Press.
- Yoliando, F.T. (2020). "A comparative study of dyslexia style guides in improving readability for people with dyslexia". *International Conference of Innovation in Media and Visual Design*, 32-37.