



Empowering Dyslexic Children's Literacy through Mobile Applications and Multisensory: Addressing the Challenges Faced by Special Needs Teachers

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ABSTRACT

Dyslexia is a common learning disorder that affects a child's ability to read, write, and spell. Special needs teachers face significant challenges in addressing the unique learning needs of dyslexic students. This paper proposes the use of mobile applications and multisensory approaches to empower dyslexic children's literacy skills and address the challenges faced by special needs teachers. The paper draws on existing literature and including field test on dyslexia and mobile learning to support the argument that mobile applications offer a cost-effective and accessible means of supporting dyslexic children's learning. The paper also explores the role of multisensory approaches in enhancing literacy skills for dyslexic children. The proposed approach has the potential to address some of the challenges faced by special needs teachers in teaching dyslexic children. For example, mobile applications can provide dyslexic students with individualized learning experiences, while multisensory approaches can help dyslexic students overcome the challenges of traditional teaching methods. Overall, the paper argues that the use of mobile applications and multisensory approaches can empower dyslexic children's literacy skills and address the challenges faced by special needs teachers. By leveraging technology and innovative teaching methods, we can create a more inclusive learning environment for dyslexic children.

Keywords: Dyslexia, Mobile application, Multisensory, Special Needs Education, Teachers.

LITERATURE REVIEW

Mobile Application

Dyslexia is a learning disorder that affects the ability to read, write and spell words accurately. Dyslexic children find it difficult to identify and differentiate between different alphabets, which can negatively impact their learning abilities. Mobile applications have become a popular tool for teaching and improving cognitive abilities in children.

A study conducted by Ahmed Aldousari,(2021) investigated the effectiveness of a mobile application in teaching dyslexic children phonological awareness. The results of the study indicated that the use of mobile applications can be effective in improving phonological awareness in dyslexic children. In another study, Tariq et al. (2016) evaluated the use of mobile applications in teaching letter-sound correspondence to dyslexic children. The study found that the use of mobile applications improved the letter-sound correspondence abilities of dyslexic children.

A study conducted by Jong and Bus (2014) investigated the use of mobile applications in teaching phonemic awareness to dyslexic children. The results of the study showed that the use of mobile applications can be effective in improving phonemic awareness in dyslexic children. In a study conducted by Yanti et al. (2022), the authors developed a mobile application that used augmented reality to teach letter recognition to dyslexic children. The study found that the use of augmented reality can be effective in teaching letter recognition to dyslexic children.

In another study, Kuo and Belland (2016) developed a mobile application that used game-based learning to teach letter recognition to dyslexic children. The study found that the use of game-based learning can be effective in teaching letter recognition to dyslexic children. Mobile applications have the potential to be effective tools in teaching alphabets to dyslexic children. The use of mobile applications can improve phonological awareness, letter-sound correspondence, and phonemic awareness. The use of augmented reality and game-based learning in mobile applications can also be effective in teaching letter recognition to dyslexic children. Therefore, this study believed that by using mobile application will be one of the best ways to overcome the challenges and help the dyslexic children in learning the alphabets.

Multisensory

Dyslexic children find it difficult to identify and differentiate between different alphabets, which can negatively impact their learning abilities. Multisensory instruction is a teaching method that uses multiple senses to enhance learning.

A study conducted by Vellutino et al. (2004) evaluated the effectiveness of a multisensory reading program in improving reading skills in dyslexic children. The program included teaching letter-sound correspondence using multisensory methods such as tracing letters in sand or shaving cream, and other kinesthetic activities. The results of the study showed that the multisensory reading program was effective in improving reading skills in dyslexic children.

In another study, Schneider et al. (2016) investigated the effectiveness of a multisensory intervention program in improving letter-sound correspondence skills in dyslexic children. The program included teaching letter-sound correspondence using visual, auditory, and kinesthetic modalities. The results of the study showed that the multisensory intervention program was effective in improving letter-sound correspondence skills in dyslexic children.

A study conducted by Smith and Goodwin (2016) evaluated the effectiveness of a multisensory approach in teaching alphabet recognition to dyslexic children. The program included teaching letter recognition using multisensory methods such as tracing letters in sand or on textured paper, and other kinesthetic activities. The results of the study showed that the multisensory approach was effective in improving alphabet recognition skills in dyslexic children.

In another study, Facchetti et al. (2018) investigated the effectiveness of a multisensory approach in improving phonological processing skills in dyslexic children. The program included teaching phonological processing using multisensory methods such as auditory, visual, and kinesthetic modalities. The results of the study showed that the multisensory approach was effective in improving phonological processing skills in dyslexic children.

Multisensory instruction is an effective teaching method in improving literacy skills in dyslexic children. The use of multisensory methods such as tracing letters in sand or on textured paper, and other kinesthetic activities, can improve letter-sound correspondence, alphabet recognition, and phonological processing skills in dyslexic children. Hence by that, this research believed that this multisensory approach of kinesthetic activities by using tactile letters will be the best choice to combine with the used of mobile application will increase the effectivity of this interventions to the students.

Challenges for Dyslexia's Teachers in Teaching Alphabets

Dyslexia is a common neurological learning disorder that affects reading and writing abilities in children and adults. Special education teachers face challenges in teaching alphabets to dyslexic students due to difficulties in phonological processing, working memory, and letter-sound associations. This literature review explores the challenges and strategies for special education teachers in teaching alphabets to dyslexic students. There were a few challenges for special needs teachers in teaching alphabets to dyslexic students and below in the table shows the challenges that the teachers must faces.



Table 1

Challenges faced by special need teachers in teaching alphabets.

Challenges / Issues	Descriptions
1. Phonological Awareness	Dyslexic students have difficulty in phonological awareness, which is the ability to identify and manipulate the sounds in words. They may struggle with letter-sound associations, blending, and segmenting sounds. This difficulty can make it challenging for teachers to teach alphabets to dyslexic students (Gross, 2014).
2. Working Memory	Dyslexic students may have poor working memory, which is the ability to store and manipulate information in the short term. This can make it challenging for them to remember the letter-sound associations and apply them in reading and writing (Swanson, 2017).
3. Visual Perception	Dyslexic students may have difficulties in visual perception, which can affect their ability to recognize and differentiate between letters. This can make it challenging for them to learn and remember the alphabet (Muter & Snowling, 2019).

Special education teachers face challenges in teaching alphabets to dyslexic students due to difficulties in phonological processing, working memory, and visual perception. However, strategies such as the multisensory approach, explicit instruction, and assistive technology can support dyslexic students in learning the alphabet.

METHODOLOGY

The data has been collected from 30 special needs teachers all over Malaysian. Interviews and online surveys have been conducted as one of the methods to collect the data. Due to the time differences and complexity of schedule between teachers we decided to conduct online surveys to ease the research study. One theoretical approach to identifying the challenges faced by the special need teachers and to identify the used of mobile applications and multisensory as potential solution is by conducting qualitative research. According to Creswell (2014), qualitative research is useful for exploring complex phenomena, understanding the perspectives of participants, and generating new theories.

Objective: The main objective of this study is to identify the special need teacher's challengers in teaching alphabets to dyslexic students and the effectivity of mobile application with multisensory as a potential solution.



To identify the challenges faced by special needs teachers, a qualitative research approach involves conducting interviews or focus groups with teachers as well and observing classroom activities has been conducted (Creswell, 2014). The goal of this research would be to gain a deep understanding of the challenges faced by special needs teachers and the context in which those challenges arise. This study has been conducted in a few phases which are pre-test, teaching session and post-test.

Once the challenges have been identified, a potential solution will be tested using a qualitative approach. For example, a mobile application and multisensory approach will be tested by observing teachers using the technology and conducting interviews to understand their experiences and perspectives (Creswell, 2014). This approach would allow researchers to gain insight into how the technology is being used, any challenges that arise during implementation, and the overall usability of the technology. Therefore, after the challenges have been identified, researcher started to conduct the test before and after the implementation of the interventions by the teachers in the classroom.

Before starting the lesson by the special needs teachers in using the interventions, the research collected the students' prior knowledge data by conducting a pre-test. This method will help researchers evaluate the progress of the students and the effectiveness of the interventions after the lesson is conducted. The test was a simple test of recognizing alphabets. Each student will be assigned one alphabet out of times and they must write the alphabets at a blank paper. There were 5 dyslexic children that contribute as be the main respondents for this study.

Multisensory (Tactile Letters)

The lesson will be starting off with today the teacher explaining lesson, which is learning alphabets. The lesson will be fun learning sessions. The teacher will assign the students to search an alphabet that has been assigned to them in the kinesthetic sand. The alphabets will be in the form of tactile letters and the students must search the tactile letters inside of the kinesthetic sand. For the multisensory part, the teacher has been offered with a few varieties of multisensory appliances that could attract students to learn and engage in the learning session. For example, this study also offered to explore the use of plasticine with tactile letters, kinesthetic sand with tactile letters, and slimes with tactile letters. This multisensory approach triggered the students brain learn and play as well as to helps them in memorizing the alphabets better. Below is their example of the multisensory approach combination for this study.



Figure 1: Tactile Letters with plasticine



Figure 2: Tactile letters with slime



Figure 3: Tactile letters with kinesthetic sand

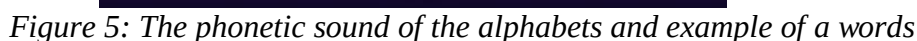
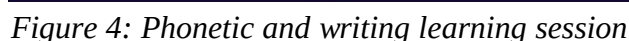
Mobile Applications

Once they found the alphabets, they will use the tactile letters to stamp on the sand and use the mobile devices or any gadget that able to scan the QR code that attached to the tactile letters to confirm the phoneme of the alphabets. This step will help them to verify does the alphabets is the correct alphabets and does it sound the same as the teachers said and describes. This lesson can be called as “Alphabets Treasure Hunts.” Once the QR code has been scan, a link will pop out and the video will automatically show on the screen about the alphabets. Each of tactile letters had its own specific QR code and video that has been programed. Therefore, this will promote a fun learning session and to expose the children to have the best of both world which is hands on learning and the use of technology learning.

One of effective method in teaching dyslexic children the alphabet is through phonemic or speech sounds. This method not only helps them visually recognize the shape of the letters but also teach them on how the sound of phoneme of the alphabets and ways to write the letters. The mobile application focuses on visually appealing videos with interactive learning features to capture and sustain the students' attention. The videos in this application use phonetic teaching methods to help dyslexic children learn how to verbally says the words.

Additionally, they promote repetitive teaching to aid in memory retention due to the short-term memory capacity of dyslexic children. This also has been addressed as one of the solutions for to overcome one of the challenges which is memory problem. The videos are divided into three parts. The first part is an introduction video that includes singing to attract the attention of the 5-8-year-old and lower target audience. The second part is the phonetic and writing teaching segment, where the audio repeats the sound of the letters twice and verbally explains how to write the letters correctly. The third part includes the phonetic sound of the letters and examples of words in which they are used, with verbal pronunciation assistance. This method helps students recognize and remember the letters by relating them to their surroundings and daily life.

This study has developed four different themes for videos for the 22 confused letters of dyslexic children. Each letter has four different theme videos to help differentiate them and attract the students' attention. This method assists visual and auditory learners with the aid of clear audio and visuals. Below are the examples of mobile application videos created for confused words for dyslexic children.



After finishing the lesson, the researcher will conduct a post-test with the students to gain new data regarding their improvement after using the interventions. The surveys included open-ended questions, and the results collected will be analyzed using the thematic analysis method with an inductive approach. The results and data collected that has been analyzed will be explained in the next chapter.



RESULT AND DISCUSSION

Challenges

The data that has been collected from surveys and interviews, identify that there were a few challenges that special needs teachers must face when teaching dyslexic children's alphabets. These teachers agreed that the age of the students they must teach alphabets to is in the range of 4 to 8 years old, and sometimes until 10 years old. Learning alphabets may seem easy to the other normal children, however, it was a challenge for these dyslexic children just to differentiate between lowercase 'd' and 'b'. Other than that, their "special ability" is also caused by other factors that make it hard for them to learn, indirectly becoming an obstacle for their teachers to help them learn these alphabets. Below are the factors that causes dyslexia children having difficulty in learning alphabets. All these data were from interviews with the special need teachers, dyslexic students, observation, and journal references from past research. All the data has been summarized in the table below.

Table 2

Factors Dyslexia children having difficulties in learning alphabets.

Factors/ Issues	Descriptions	Source
1. Phonological processing	Children with dyslexia may have difficulty with phonological processing, which is the ability to identify and manipulate the sounds of language. This can make it challenging for them to learn the sounds associated with individual letters of the alphabet. According to a study by Snowling et al. (2003), phonological processing difficulties are a core feature of dyslexia.	Snowling MJ, Gallagher A, Frith U(2003). Family risk of dyslexia is continuous: individual differences in the precursors of reading skill. <i>Child Dev.</i> (2):358-73. doi: 10.1111/1467-8624.7402003. PMID: 12705560.
2. Visual processing	Dyslexia may also impact a child's visual processing abilities, making it difficult for them to recognize and differentiate between letters. This can result in difficulties with letter reversals and mirror writing. According to a study by Stein (2014),	Stein J. (2014). Dyslexia: the Role of Vision and Visual Attention. <i>Curr Dev Disord Rep.</i> ;1(4):267-280. doi: 10.1007/s40474-014-0030-6. PMID:



	visual processing impairments are a key feature of dyslexia.	25346883; PMCID: PMC4203994.
3. Working memory	Children with dyslexia may also struggle with working memory, which is the ability to hold and manipulate information in the mind. This can make it challenging for them to remember the sounds associated with individual letters and to apply these sounds when reading or spelling. According to a study by Gathercole and Alloway (2008), working memory impairments are commonly associated with dyslexia.	Susan Gathercole & Tracy Packiam Alloway (2008). <i>Working Memory and Learning: A Practical Guide for Teachers</i> 1st Edition. <i>SAGE Publications Ltd</i> . ISBN-13 978-1412936132 Snowling MJ, Gallagher A, Frith U(2003). Family risk of dyslexia is continuous: individual differences in the precursors of reading skill. <i>Child Dev.</i> (2):358-73. doi: 10.1111/1467-8624.7402003. PMID: 12705560.
4. Genetics	Dyslexia is also believed to have a genetic component, with studies suggesting that certain genes may increase the likelihood of a child developing dyslexia. For example, a study by Galaburda et al. (2006) found that dyslexia is associated with variations in the genes responsible for brain development.	Galaburda, A., LoTurco, J., Ramus, F., Fitch R. Holly & Rosen Glenn D., (2006). From genes to behavior in developmental dyslexia. <i>Nat Neurosci</i> 9, 1213–1217 https://doi.org/10.1038/nn1772

These data are the main leads data that helps researcher to identify and relate the factors with the challengers that been faced by the teachers. These factors and challengers are interrelated to each other that cause the impact after the lessons. Therefore, below we summarized the challenges that special needs teachers have to face in teaching alphabets to dyslexic children.



Teaching dyslexic children, the alphabet can present several challenges for special education teachers. Dyslexia is a specific learning difficulty that affects a person's ability to read, write and spell accurately. It can also affect the way dyslexic children process and recognize letters, making it harder for them to learn the alphabet. In this response, the researcher will discuss some of the challenges faced by special education teachers in teaching dyslexic children the alphabet.

Phonology / Phoneme

Dyslexic children may have difficulty recognizing the sounds associated with individual letters, which can hinder their ability to read and write. Dyslexic students may find it difficult to associate letters with their corresponding sounds. Therefore, teachers have been suggested to use multisensory teaching techniques that involve sight, sound, touch, and movement to help reinforce letter-sound associations. A study by Catts et al. (1999) found that phonemic awareness was the most important predictor of reading achievement in dyslexic children. Therefore, special education teachers need to develop and implement strategies that help dyslexic children develop phonemic awareness.

Another challenge is developing letter-sound associations. Dyslexic children may struggle to associate individual letters with their corresponding sounds, making it difficult for them to read and write. A study by Lyon et al. (2003) found that dyslexic children had difficulties in phonological processing, which includes the ability to identify and manipulate individual sounds in words. Therefore, special education teachers need to use explicit and systematic instruction to help dyslexic children develop letter-sound associations.

Maintaining motivation and engagement during lesson.

Another challenge is maintaining motivation and engagement. Dyslexic children may find learning the alphabet challenging, which can lead to frustration and disengagement. A study by Siegel and Smythe (2004) found that dyslexic children had lower self-esteem and were more likely to experience negative emotions related to reading and writing. Therefore, special education teachers need to use a variety of engaging and motivating instructional strategies that cater to the learning needs of dyslexic children.

One example of a motivation theory that this study applied is the ARCS Model of Motivational Design by John Keller. This model suggests that there are four essential components to motivate learners. Below the example of the model.

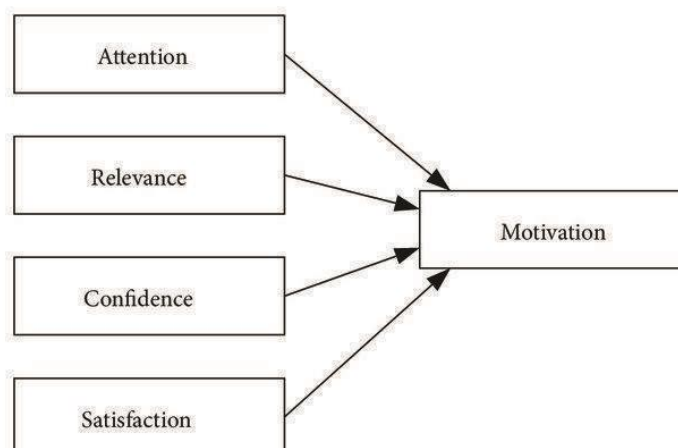


Figure 6: ARCS Model by John Keller

There were 4 essential that can be applied in this study that refers to the motivational ARCS model by John Keller. Below show a table that will briefly explain the used of the model.

Table 3
ARCS's information table

Attention	attract and maintain the learner's attention by using novel and interesting instructional materials.
Relevance	connect the learning to the learners' goals and interests so that they can see the relevance and importance of what they are learning.
Confidence	create a supportive learning environment that builds the learners' confidence and competence.
Satisfaction	provide opportunities for learners to apply what they have learned and receive feedback to experience a sense of accomplishment and satisfaction

Using the ARCS Model in the context of dyslexia, educators can create multisensory and interactive learning materials that capture the attention of dyslexic learners. This can include the use of visuals, sounds, and animations that engage the learners' senses and help them to remember information more effectively. Mobile applications can also be designed to incorporate the relevance component by allowing dyslexic children to personalize their learning experience and connect the content to their interests and goals.



The confidence component can be addressed by providing scaffolding and support by assistive technologies such as text-to-speech and speech recognition software that help dyslexic children to overcome their reading difficulties. Finally, the satisfaction component can be achieved by providing dyslexic children with opportunities to apply what they have learned in a practical setting and receive positive feedback from their peers and teachers. By using the ARCS Model in combination with multisensory and mobile applications, educators can create a motivating and effective learning environment for dyslexic children that addresses their specific needs and challenges.

Difficulty with letter recognition

Dyslexic students may struggle to recognize letters, particularly when they are presented in unfamiliar fonts or handwriting styles. Teachers can help by using clear and consistent letter formation and font styles and providing plenty of practice opportunities. Dyslexic students may struggle with sequencing letters in the correct order. Teachers can use activities that involve sequencing letters, such as puzzles or word games, to help build this skill. Therefore, in this study we customized the mobile application and tactile letters with specific criteria based on dyslexic students' preferences. This will allow them to have a better visual learning and proper practice for writing.

Challenges with handwriting

Dyslexic students may struggle with handwriting, which can make it difficult to write letters and words accurately. Teachers can provide accommodations such as extra time for written assignments or the use of assistive technology to help overcome this challenge. As in this study, we have included a specific section and part for both phase which are in multisensory phase and mobile application phase. In this study, we have included the kinesthetic activities that allowed the students to use the multisensory appliances such as plasticine, kinesthetic sand, slimes, and tactile letters to incorporate the writing practice using the multisensory appliances. Other than that, in the mobile application videos also we, prioritize the writing skills as the first part of the video juts to emphasize the importance of writing the skills.

The usability of the mobile application with multisensory

The used of multisensory and mobile applications have been increasingly utilized in special education to enhance students' engagement and motivation in learning. In this analysis, we will examine the usability of mobile applications with multisensory features in special education. Based on the results of the surveys and field test that has been conducted among special needs teachers and dyslexic students. 30 special needs teachers' opinions have been gathered on the usability of mobile applications with multisensory features. The survey included questions on the effectiveness of the applications in overcoming the dilemma that special needs teachers must face in teaching alphabets to dyslexic students.

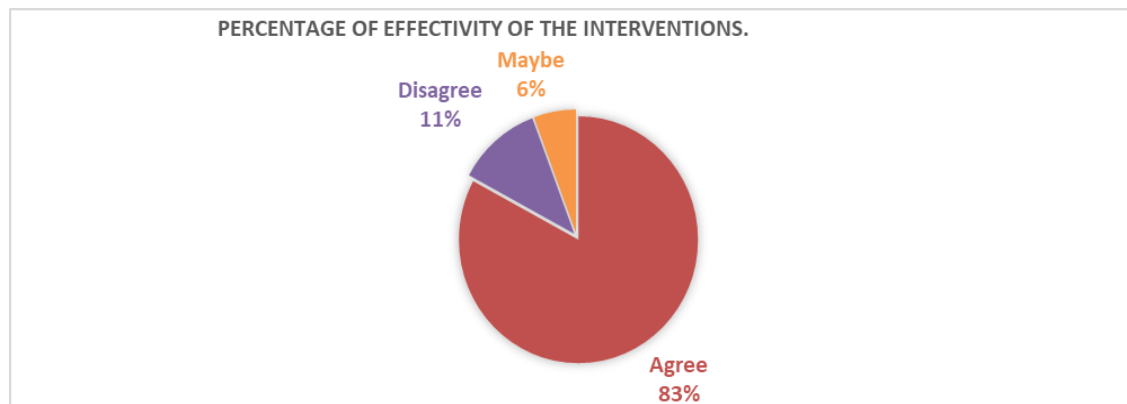


Figure 7: Percentage of effectivity of the interventions by the special needs teacher in teaching alphabets to dyslexic children

The results of this study shown 83% special needs teachers agreed that the use of multisensory mobile applications was effective in teaching alphabets to dyslexia children. Especially in maintaining students' engagement and motivation during lessons. Meanwhile there were 11% and 6 % teachers who in between and not agree that the interventions are effective in overcoming the challengers. Other than that, the teachers cited the interactive and immersive nature of the applications, which appealed to the students' different learning styles and preferences. Additionally, the use of multisensory features, such as tactile letters, audio, and visual cues, allowed for a more inclusive learning experience for students. Below show a table that categorized the challenges that faced by the teachers and the interventions characteristics that able to overcomes the challenges.

Table 4

Challenges faced by the teachers and the interventions characteristics that able to overcomes the challenges.

Challenges / Issues	Interventions characteristics that customized to solve the issues.
1. Phonological processing	Mobile application video that consists of letter-sound that help dyslexia students to follow the sound of the alphabets. This also include the used of repetitive method to helps the students to able to follow in learning how to verbally pronounce the alphabets.
2. Visual processing	- Available in 4 different themes for each alphabet that help the students to differentiate the alphabets. - The mobile applications video has been developed by using specific animation, colors, and fonts that suitable for dyslexia children.



3. Maintaining motivation and engagement during lesson.	- Implement the combination of fun learning with the used of multisensory and the use of technology. - The mobile application videos have been developed specifically with special custom of musical and fun animation for the students.
1. Difficulty with letter recognition / Working memory	- Available in repetitive mode for each part to emphasize the subject. - Interactive kinesthetic learning by using multisensory tactile letters, kinesthetic sand, slime, and other appliances.
4. Challenges with handwriting.	Include writing teaching parts in repetitive mode.

Overall, teachers agree that these interventions can support dyslexic students in learning the alphabets by using multisensory teaching techniques with the support of mobile application create a better teaching and learning experience for the students and teachers. It's important to remember that dyslexia are a neurological difference, not a lack of intelligence, and with the right support, dyslexic students can achieve great things.

CONCLUSION

In conclusion, empowering dyslexic children's literacy using mobile applications and multisensory approaches can significantly address the challenges faced by special needs teachers in teaching the alphabet to these students. By leveraging technology and multisensory techniques, special needs teachers can provide interactive and engaging learning experiences that cater to the unique needs and learning styles of dyslexic children. Mobile applications offer a range of features such as animations, and interactive exercises that enable dyslexic students to visualize and understand the relationships between letters and sounds. Multisensory approaches that incorporate auditory, visual, and kinesthetic learning can also be beneficial for teaching dyslexic children as they engage different parts of the brain and reinforce learning.

By embracing these technologies, special needs teachers can create a supportive and inclusive learning environment that empowers dyslexic children to develop their literacy skills and reach their full potential. However, it is essential to note that these technologies should not replace traditional teaching methods but be used as supplements to enhance the learning experience. Ultimately, the use of mobile applications and multisensory approaches can pave the way for dyslexic children to achieve academic success and thrive in their future endeavors.



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Conflict of Interest

The authors declare no conflict of interest.

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	Noratikah Abdullah was born in Malaysia in 21st August 1997. She was raised and born in small village in one of states in Malaysia. She continues her’s studies in her first degree at University Sains Malaysia in Bachelor of Education with honour, major in TESOL or Teaching of English to speakers of other languages with a minor study in technology studies or multimedia. She continues her studies at USM or Universiti Sains Malaysia, Gelugor, Pineng, Malaysia, on 2018 until she successfully earner her first degree on 2021
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