

Lexiroom: Web-Based Learning Media to Increase Phonological Awareness for Indonesian Dyslexic Children

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ABSTRACT

Children with dyslexia may have adequate cognitive abilities but they often show considerable difficulties in reading where they are less accurate in spelling and pronouncing words. Phonological deficit is the main cause of reading disorders in dyslexic children, and hence, developing competence in phonological awareness is important to increase children's sensitivity to the structure of a word. This study aims to develop a web-based assistive technology called Lexiroom for Indonesian dyslexic children to increase their phonological awareness. This includes the aspects of syllable awareness, segmenting words into sounds, and manipulating sounds. As a preliminary study, the proposed learning media is implemented using a single subject design with a research and development approach. The results show that Lexiroom can improve the phonological awareness of a child diagnosed with dyslexia. However, Lexiroom still has limitations in doing speech recognition, so in making the next media it is necessary to consider the structure in speech recognition assets to minimize error answers that are inputted in the form of voice.

Keywords: Dyslexia, phonological awareness, Lexiroom

INTRODUCTION

Based on the characteristics of the development of the industrial revolution 4.0, changes in learning methods for dyslexic children using software media are a basic need for this generation. One of the studies is the Lexipal application using a gamification approach and implementing designs in software applications, and measuring the effectiveness of the design on the desired psychological results, namely motivating dyslexic children (Risqi, 2015).

Many researchers also recommend guidelines for dyslexia-friendly websites including preferred options according to their needs and preferences (Berget et al., 2016; Evett & Brown, 2005; Rello, 2014). Background color also has an impact on the legibility of text for people with dyslexia (Rello, L., & Bigham, 2017). Therefore, warm color backgrounds (peach, orange, and yellow) are used to significantly improve reading performance over cool backgrounds (blue, blue gray and green). In addition, based on another study, it was found that 67% of participants with dyslexia chose Arial as the most suitable font type and 83% of dyslexic participants noted that the appropriate contrast between the background and font color made it easier to find information and the website was clearer (Kous & Polančič, 2019).

The Orton-Gillingham approach (multi-sensory teaching variation) and computer technology tools also teach dyslexic children such as spelling and recognizing words using a mobile tablet (Purkayastha et al., 2012).

One of the studies on a spelling training software for dyslexic children is by converting words into multi-sensory representations consisting of visual and auditory codes (eg colors and shapes representing individual letter information; associating different colors with the same letter as b. and d, then enter the phonological code and control word selection based on a phoneme-based model (Kast et al., 2011). Multi-sensory media representation is needed because it can help the

long-term remembering process in the learning process. This is because dyslexic readers often show poor short-term memory of words and they have difficulty performing phonological manipulations that require maintaining phonological information while it is being transformed (Banai & Ahissar, 2004; Verhagen & Leseman, 2016). They implemented designs in software applications and measured the effectiveness of the design on the desired psychological results, namely motivating dyslexic children.

This study aims to develop a web-based learning media named Lexiroom to increase the phonological awareness of Indonesian dyslexic children. An initial study was conducted where LexiRoom previously only displayed text-to-speech with a toolbar using color when the highlighted text was being read as a whole sentence (Rosita et al., 2020). For this research, the LexiRoom web will be developed into a phonological learning program to increase phonological awareness in dyslexic children. This program has a level in the learning process using web software that provides phonological awareness learning rooms.

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How to cite this article: Rosita T, Nurihsan J, Juhanaini, Sunardi (2022). Lexiroom: Web-Based Learning Media to Increase Phonological Awareness for Indonesian Dyslexic Children. Pegem Journal of Education and Instruction, Vol. 12, No. 4, 2022, 302-309

Source of support: Nil

Conflict of interest: None.

DOI: 10.47750/pegegog.12.04.31

Received : 01.04.2022

Accepted : 19.06 .2022

Published: 01.10.2022

Phonological awareness allows a person to notice, distinguish, remember, and manipulate sounds at the level of sentences, words, syllables, and phonemes (sounds). Phonological awareness is the difficulty in analyzing, storing and manipulating sounds in a language into the smallest parts and mapping them into writing. (Carroll, J. M., Mundy, I. R., & Cunningham, 2014). Indonesian phonemes include vowel phonemes, diphthong phonemes, and consonant phonemes. The number of consonant phonemes is 25, the number of vowel phonemes is 7, and the number of diphthong phonemes is 3 (Setyadi, A., & Wasisto, 2018).

The main problem for dyslexic children in recognizing a word is a phonological coding deficit involving the process of translating subvocal print units into sounds (Pennington et al., 1991). This deficit causes reading disorders as it is recognized as the difficulties in translating letters into sounds, breaking words into phonemes, and phonemic manipulation (Nation & Snowling, 2004). When dyslexic children have a deficit in phonics, their spelling becomes less accurate. Thus, if phonological awareness is still lacking, it will lead to inaccurate knowledge resulting in wrong conclusions during reading and having a low mental representation of the texts read (Kendeou, P., & Van Den Broek, 2005; Van Den Broek, 2010) reading times.

Based on data from the International Dyslexia Association (2017, p. 3) that some people with dyslexia also manage to learn reading and spelling assignments early, especially with excellent teaching, but then experience problems when reading is more complex, so language skills are also needed, such as grammar, understanding textbook material, and writing essays. However, currently there are still many teachers who do not understand the learning disabilities in elementary school children caused by dyslexia which is the main factor causing the low achievement of student learning outcomes (Supena, A., & Dewi, 2021).

The Indonesian Dyslexia Association as well as a diagnostic and intervention center for dyslexic children revealed that studies on dyslexia in Indonesia are still very few compared to the breadth of problems that require solutions (Rachmawati et al., 2019). Thus, dyslexic children need the support of a set of media to learn good phonological skills that can lead to better reading skills. A set of learning media can help them to improve their phonological skills that can lead to better reading skills. Changes in learning methods for dyslexic children including the use of software can be effective to assist them to learn.

Lexiroom as a web-based phonological learning media is a form of strong optimism for future developments in inclusive education, where technological advances collaborate in learning practices by providing accessibility for optimizing learning for dyslexic children.

METHOD

Research Design

This research used a research and development approach which is also known as development research. The development is a process of needs analysis, material creation, goal achievement, learning design and testing and revision of program achievements to improve student learning outcomes (Heinich, R., Molenda, M., Russell, J. D., and Smaldino, 2002). The LexiRoom mobile web development research uses the ADDIE model, namely there are five stages in the ADDIE development model, namely: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The trial of LexiRoom media products uses a quasi-experimental technique during the learning process. Quasi-experimental that is testing the impact of a treatment or intervention on research results (Creswell, 2013). The design used in this study is a single-subject research design that focuses on examining and changing behavior in individuals or groups (Shaughnessy, John J, 2003).

Measurement of the dependent variable or target behavior was repeated with a certain period of time, comparisons were made on the same subject under different conditions, namely the baseline condition (natural condition before being given the intervention) and the intervention condition. The researcher used a reversal design A – B (Sunanto, J., Takeuchi, K., & Nakata, 2006).

Characteristics of the Participating Student

The sole subject in this study was a dyslexic child in grade VI of Elementary School with the initials CMP. Based on the results of psychological examinations conducted by psychologists, CMP has an average level of intelligence (FIQ=105, Wechsler scale), while potential intelligence is above average (OIQ=112, Wechsler scale).

Data analysis

Data analysis uses visual analysis with graphic data, this is because Single Subject Research data analysis displays continuous measurement data as the progress of the experiment (Neuman & McCormick, 1995). The components analyzed are the amount of data in each condition or the length of the condition, the level of stability and data change, and the trend towards the graph (Sunanto, J., Takeuchi, K., & Nakata, 2006). The media expert validation criteria are using descriptive analysis. By changing the average score of indicators in the form of quantitative data into qualitative categories

RESEARCH RESULTS

The results of the needs analysis of the characteristics of dyslexic students when reading often show poor short-term memory for words and difficulties in performing phonological

manipulations that require maintaining phonological information while it is being changed. So that learning with LexiRoom will be focused on increasing the phonological awareness of dyslexic children in the aspect of syllable awareness, segmenting words into sounds, and manipulating sounds. Then from the results of the analysis, a phonological awareness learning plan is made. The learning design in LexiRoom consists of 3 levels of phonological awareness learning. At Level 1, namely learning syllable awareness based on syllables in Indonesian with a total of 15 learning questions, level 2 namely segmenting words into sounds with a total of 10 learning questions, and level 3 namely manipulating sounds with a total of 10 learning questions.

Based on the design results above, LexiRoom product development includes web display, programming, image or graphic creation, text typing, voice input, and practice questions. The results of LexiRoom development can be seen in the following figure 1:

Based on Figure 2, on the mainboard page there is level 1, namely syllable awareness learning. Children will work on 15 questions by mentioning syllables and writing them on the screen. The following is an overview of the level 1 questions found in Lexiroom:

In Figure 2, at the top center of the page there is a question board that contains a question mark icon to display a tutorial video for level 1 work, a voice icon to listen to questions, words from questions, and input entered by the user via the virtual keyboard. Then there is a scoreboard and feedback from the answer.

At level 2, namely learning segmenting words into sounds. Children will work on 10 questions by writing down the spelling of the letters of a word that is conveyed by each question in audio.

At level 3, namely learning to manipulate sounds. Children will work on 10 questions by writing a word that has changed one of the letters so that it will become a new word. Each question given at level 3 is also in audio form.

If the child has worked on each level, then there is a scoreboard. The scoreboard is the final page if all questions at a level have been answered. On this page, the accumulated scores of all questions will be displayed. In addition, the duration of working on all questions from that level is also displayed. There are 5 assessment criteria for the final score, namely very low, low, quite good, good, and very good. An example of a level 1 scoreboard :

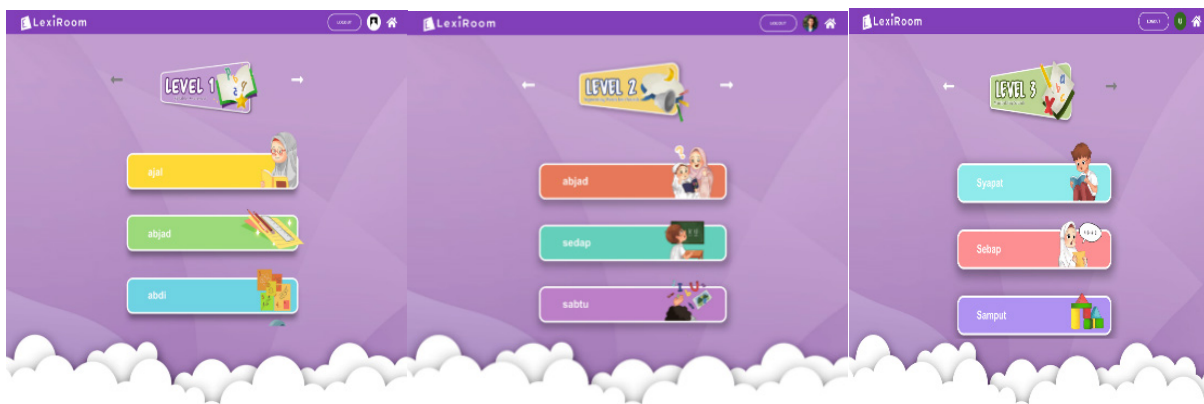


Fig. 1: Homeboard, mainboard and course menu level 1, level 2, and level 3

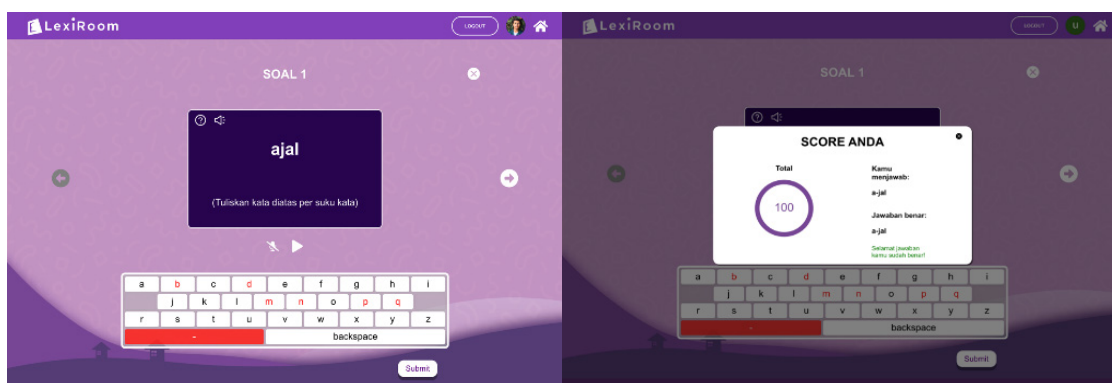


Figure 2. Level 1 learning menu

Based on the results of media expert validation in terms of general aspects, software, and visual communication, it is concluded that LexiRoom is feasible to use. Furthermore, lexioroom is used as an intervention medium to increase CMP phonological awareness.

This research was conducted for eight sessions. In the baseline phase there were three sessions and in the intervention phase there were five sessions. Based on the results of the intervention in CMP, there was a very significant increase in the syllable awareness aspect, and in the segmenting words

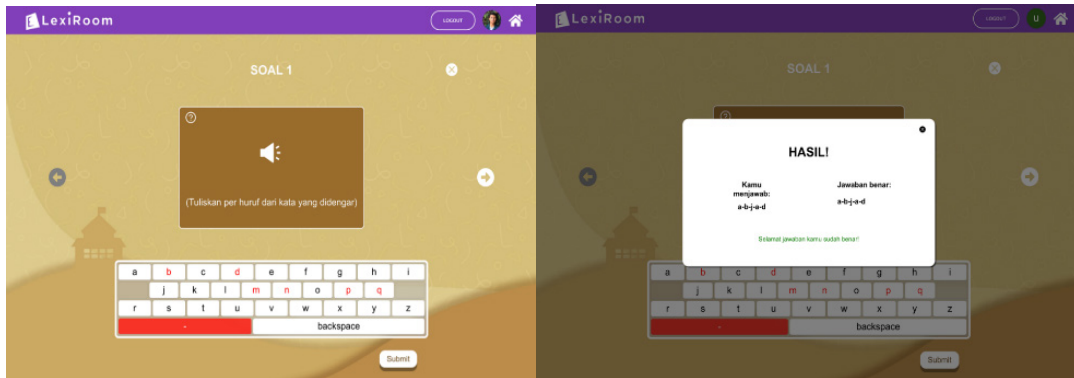


Fig. 3: Level 2 learning menu

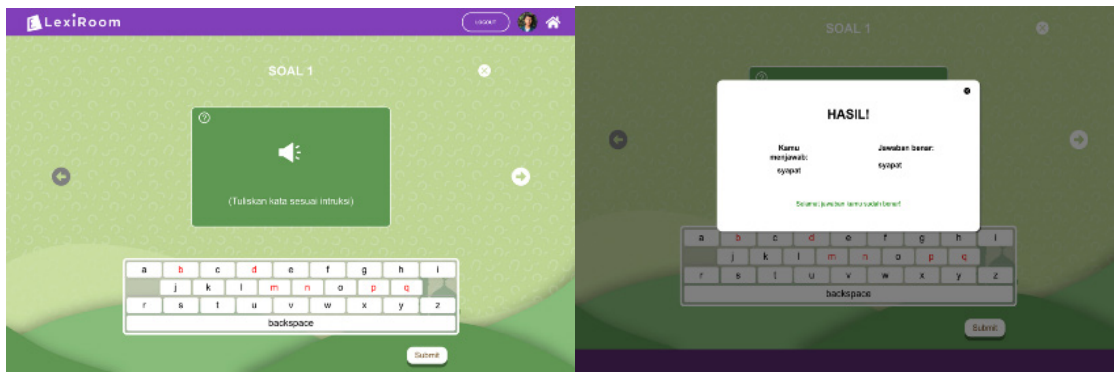


Figure 4. Level 3 learning menu

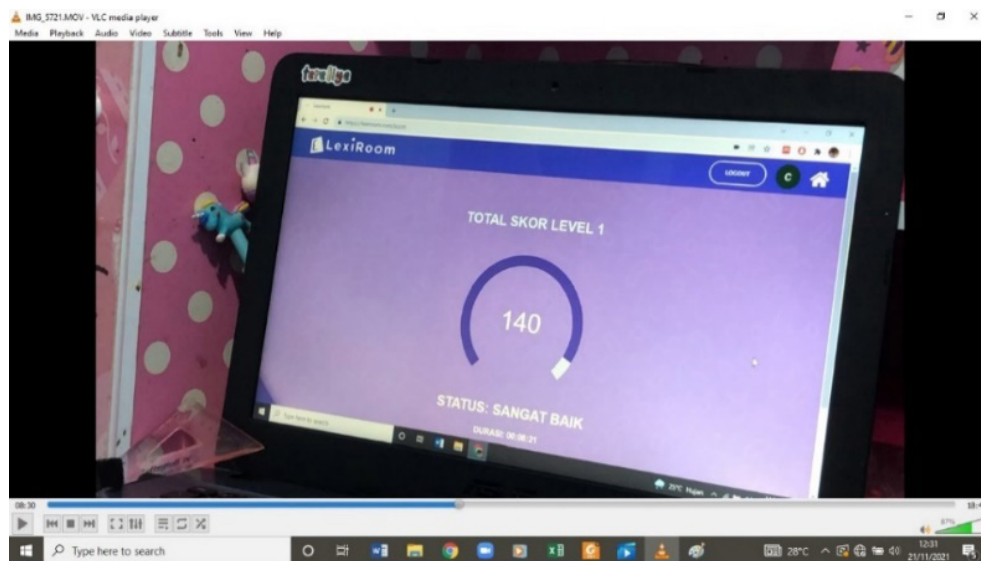


Fig. 5: LexiRoom Scoreboard

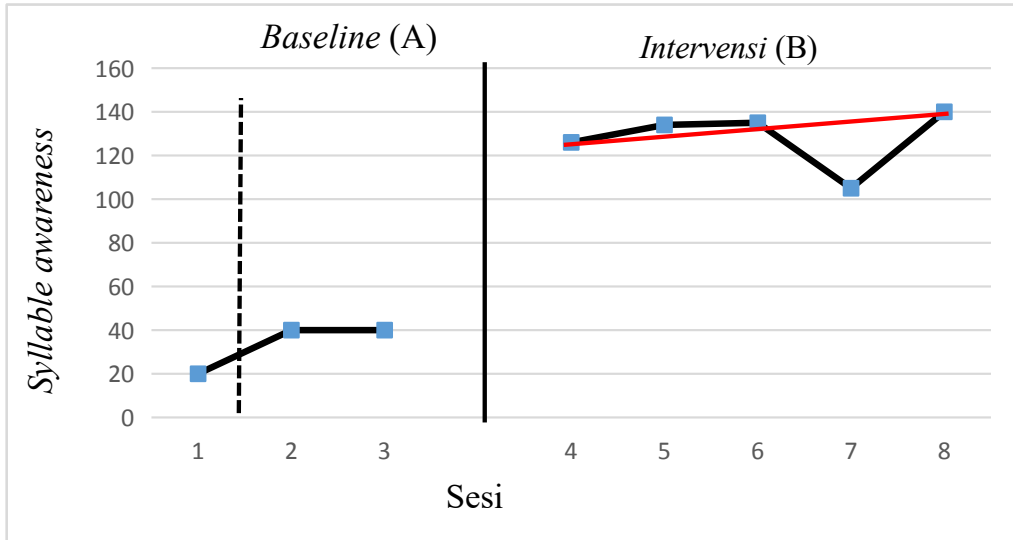


Fig. 6: The results of the syllable awareness aspect score

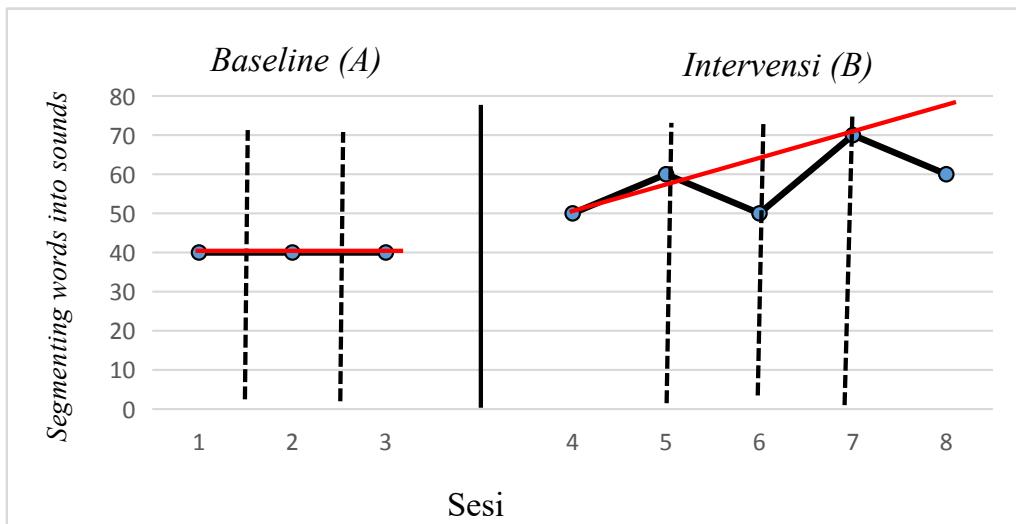


Fig. 7: The result of the score for segmenting words into sounds

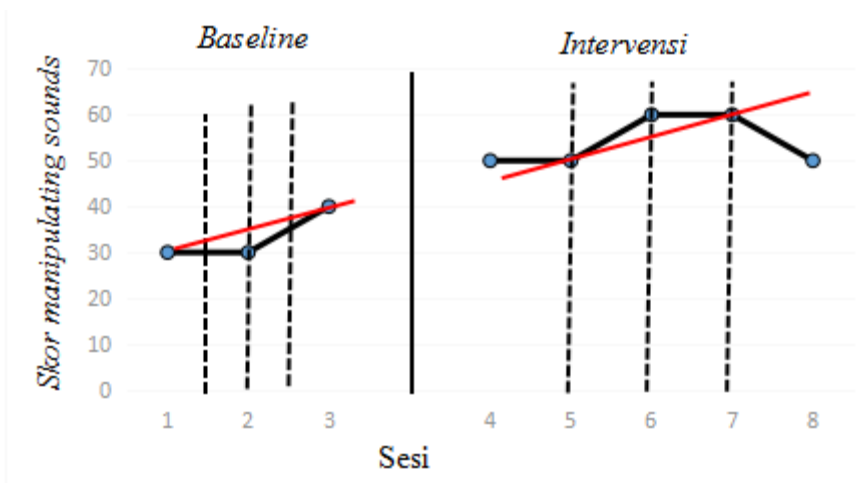


Figure 8. Score results for the aspect of manipulating sounds

Table 1: Summary of the results of visual analysis between conditions on the syllable awareness aspect

<i>Condition Comparison</i>	<i>B1/A1 (2:1)</i>
Number of variables changed	1
Change of direction and its effects	- +
Stability change	Variable to stable
Level change	126-40 = (+) 86
Overlap Percentage	0%

Table 3: Summary of the results of visual analysis between conditions in the aspect of manipulating sounds

<i>Condition Comparison</i>	<i>B1/A1 (2:1)</i>
Number of variables changed	1
Change of direction and its effects	+ +
Stability change	Variable to stable
Level change	40-50 = (+) 10
Overlap Percentage	0%

into sounds and manipulating sounds aspects there was a significant increase.

- The figure 6, figure 7, and figure 8 show the difference in the scores of the baseline and intervention sessions

Based on the data from Figure 6, Figure 7, and Figure 8, an analysis of the conditions in each aspect was obtained. The analysis between the conditions of the syllable awareness aspect can be seen in Table 1, the analysis between the conditions of the segmenting words into sounds aspect can be seen in Table 2, and the analysis between the conditions of the manipulating sounds aspect can be seen in Table 3:

Based on the results of the study, it was shown that after CMP was given intervention with LexiRoom media, it could increase phonological awareness in the aspects of syllable awareness, segmenting words into sounds, and manipulating sounds. The level of change in syllable awareness is to earn +86 points, the level of change in segmenting words into sounds, and manipulating sounds is to earn +10 points. The level of change in this level is obtained from the difference between the initial point of the intervention and the end point of the baseline (the + sign indicates improving). In addition, the results of the overlap percentage test yield 0%, this shows the smaller the better the influence of the intervention on the target behavior.

DISCUSSION

Based on the results of the implementation of lexiroom on CMP, there is agreement with several studies that use information technology to overcome dyslexia problems and most use technology tools to provide some form of assistive teaching. Many researchers recommend guidelines for dyslexia-friendly websites including preferred options according to their needs and preferences (Evet & Brown, 2005; Studies et al., 2016).

Table 2: Summary of the results of visual analysis between conditions in the aspect of segmenting words into sounds

<i>Condition Comparison</i>	<i>B1/A1 (2:1)</i>
Number of variables changed	1
Change of direction and its effects	- +
Stability change	Stable to stable
Level change	40-50 = (+) 10
Overlap Percentage	0%

People with dyslexia also prefer high contrast between text and background colors, such as a combination of mucky green text on a brown background and blue text on a yellow background (Evet & Brown, 2005). In addition, it uses brown text on a mucky green background and blue text on a yellow background (Gathercole & Pickering, 2000). Based on this, the development of LexiRoom media refers to previous research, the background color with a combination of mucky green text on a brown background makes children more interested in working on phonological learning questions. This was obtained based on the results of the interview at the end of the intervention.

Besides being related to the background color, the questions are presented in Arial font and LexiRoom has also developed a virtual keyboard that is tailored to the needs of dyslexic children. Dyslexic children tend to be inverted in writing the letters b, d, m, n, p, and q, so to optimize the coding of letters, the virtual keyboard is designed by presenting a special alphabet for lowercase letters and for these letters it is colored red so that it provides a contrasting color. In addition, the Arial keyboard font has 24 pixels, so that children can easily remember it during the implementation process. Thus, people with dyslexia have different abilities and different preferences regarding color, type and font size (De Santana et al., 2012). Thus, the use of background colors, virtual keyboards by considering keyboard fonts is an extrinsic factor that can minimize learning barriers for dyslexic children in Lexiroom media. Extrinsic barriers have a high influence on children's motivation and learning outcomes (Nguyen, 2021).

The results of the evaluation carried out by LexiRoom media validation from general aspects, software engineering, visual communication, material content, display and programs show that each indicator of each of these aspects has very valid criteria. Thus, the conclusion is that LexiRoom learning media is feasible to use.

The evaluation of the use of Lexiroom as a phonological learning intervention, namely in the aspect of syllable awareness, the results of the intervention were quite significant (+86 points) compared to the baseline condition. However, when CMP was in the intervention session of segmenting words into sounds and manipulating sounds, the score increased by +10 points compared to the baseline condition. This is because

phonological learning in the aspect of segmenting words into sounds and manipulating sounds is level 2 and level 3 so that it has a learning level with a different level of difficulty with syllable awareness at level 1.

Based on the data from the intervention, it shows that to acquire cognitive skills in a language structure, it requires memory power as a technical implementation. Meanwhile, children with dyslexia have poor short-term memory for words and have difficulty performing phonological manipulations that require maintaining phonological information while it is being transformed (Banai, K., & Ahissar, 2004; Gathercole, S. E., Alloway, T. P., Willis, C., & Adams, 2006; Verhagen, J., & Leseman, 2016). So that when CMP is in the intervention session of segmenting words into sounds and manipulating sounds, the increase is quite different from syllable awareness. Besides being related to short-term memory, auditory temporal processing (ATP) is very influential on the success of the intervention session segmenting words into sounds and manipulating sounds. Auditory temporal processing (ATP) reflects an individual's ability to process sound quickly (Fostick, L., & Babkoff, 2013). Based on ATP theory, there is conformity with CMP conditions during intervention sessions, often repeating questions in the media Lexiroom before he answered it, but the results were not optimal and qualitatively from the answers in written form that he worked on some of the errors were still the same (for example, the letter p was swapped with the letter b). According to the ATP deficit theory for dyslexia the difficulty in processing fast stimuli that is appropriate interferes with coding of sounds needed for good phonological representation in reading (Goswami, U., Fosker, T., Huss, M., Mead, N., & Szűcs, 2011) children with developmental dyslexia have a specific difficulty with the neural representation of the sound structure (phonological structure). Therefore, CMP takes longer to learn at the level of segmenting words into sounds and manipulating sounds

CONCLUSION

LexiRoom web-based is a learning media to increase phonological awareness in the aspect of syllable awareness, segmenting words into sounds, and manipulating sound after being validated that LexiRoom is suitable to be used for phonological learning for dyslexic children. The results of the implementation of lexiroom media are able to increase the phonological awareness of dyslexic children in the aspect of syllable awareness, segmenting words into sounds, and manipulating sounds.

The results of this study have implications for being a reference in the phonological learning process in children with dyslexia barriers to be more fun and calming and in accordance with the expected goals. The implication of this research is that it can also provide information to teachers regarding the

description of the barriers for dyslexic children in reading, so that teachers are able to increase understanding regarding the barriers of dyslexic children and can help them to successfully complete assignments and increase their motivation in the learning process.

As for recommendations that can be taken into consideration for those who need it, namely Lexiroom still has limitations in doing speech recognition, so that when inputting answers in the form of words in the form of sound when it is being converted into a digital signal it can only reach 70% accuracy. Even when the weather conditions are heavy rain, it tends to error when processing answers in the form of voice. Thus, in making the next media, it is necessary to consider the structure of speech recognition assets, to minimize error answers that are inputted in the form of voice.

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