

# Translating Interaction Design Guidelines for Dyslexic Children's Reading Application

Fakhrul Anuar Aziz, Husniza Husni, and Zulikha Jamaludin

**Abstract**—This paper presents a translation of interaction design (IxD) guidelines into a working prototype of dyslexic children's reading application in Bahasa Melayu. The IxD guideline was specifically designed and developed with the motivation to help ease and reduce dyslexic children's difficulties in reading. It is well established that dyslexics, due to dyslexia, have difficulties to learn, especially when it comes to reading that is caused by visual and auditory deficits. Unfortunately, reading applications, mostly in English language, are not designed specifically for dyslexics in terms of its form, content, and behaviour for such application. Hence, to help them read better, an IxD guidelines tailored specifically for dyslexic children is proposed. These guidelines are translated into prototype and show how the intended, suitable form, content, and behaviour would be. The Goal Directed Design (GDD) methodology is used in order to add customized guidelines and to embed the guidelines into the prototype.

**Index Terms**—Customised IxD guidelines, interaction design, design requirements, reading application prototype, dyslexic children.

## I. INTRODUCTION

A computer-based reading application should be designed in such a way that children would find it attractive, interesting, fun, and thus would motivate them to learn and promote positive feeling when using it. What more if the computer-based reading application is an interactive one where children engage in using the application and thus, engage in learning to read. Indeed, research have found that children are more motivated in learning when using computers as they provides a whole new experience in learning the fun way [1-2]. The same goes for dyslexic children.

The challenge with dyslexic children is their specific reading difficulties called dyslexia. Dyslexia impedes the ability to read due to somewhat unique phenomena in the brain. Apparently, dyslexics use different parts of the brain to process information cues for reading as have been proven by fMRI images, illustrated in Fig. 1 [3]. The condition is caused by either one of the deficits: auditory deficit, visual deficit, or visual-auditory deficit [4-6], which cause the phonological deficit that impedes phoneme awareness –

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thus, creating difficulties to associate grapheme with its corresponding phoneme. Failure to do so creates problems where they often read incorrectly, hence impede the progress in learning to read.

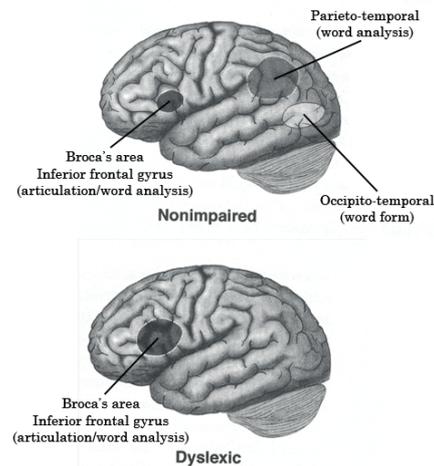


Fig. 1. Comparison between normal brain and dyslexic brain. The highlighted areas represent activated areas in the brain while reading.

For some dyslexics, the problem is caused by visual deficit thus it is important to minimize their difficulties by providing a specific design for interactive reading application that could ease and aid their reading process. For example, a real encounter with a dyslexic child taught that he can read correctly given a suitable design or representation of reading material. In this case, he can only read correctly when using blue as the background colour for text and he is progressing well in school, reading fluently with text on blue papers. This scenario motivated the development of the dyslexic-focused IxD guideline. Hence, the aim of this paper is to present the translation of the IxD guidelines into a working prototype and to highlight the features that could ease the reading process.

## II. INTERACTION DESIGN FOR DYSLEXIC CHILDREN

IxD is a field that focuses on design for user experience (UX). However, it is more geared towards complex dialogue between a human and an interactive device, in this case a computer [7]. IxD embodies three dimensions – form, content, and behaviour as depicted in Fig. 2. A *form* represents the physical layout of the interface that includes among others colours, fonts, buttons, labels, figures. *Content* refers to what is being presented to user. *Behaviour* denotes how the content is presented to user and concerns with user experience and user's feeling after accessing the content presented.

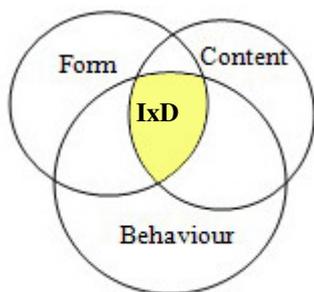


Fig. 2. IxD dimensions with form, content, and behaviour. The IxD, however, is more focused towards the behavioral design aiming at positive user experience and thus positive feeling about using an application.

A good design often brings out positive feelings to users [8]. It is inline with core affect theory [9] that suggests that positive affect should be realized from within the user for a maximum and effective effect of any application. Hence, a good design could help stimulate dyslexic children to learn to read by providing an interactive interface, which is specifically designed to compensate their difficulties in order to facilitate the process of learning. Hence, with the impedement to learning to read causes by visual and auditory deficits, or worse of all the combination of the two deficits, dyslexic children need special attention and

exclusive visual design in interactive application such as a reading tutor.

Suitable visual design may assist them to use the courseware [10]. This effort can help to encourage and motivate them to read. It is therefore potential to lessen their difficulties and provide them with better, more flexible reading environment. Hence, we repackage the IxD guideline specifically for dyslexic children’s reading application. The elements included in the guidelines are obtained from the following method.

To develop the guideline, first we have conducted user research. This includes library search activity to gather information about general dyslexic children’s characteristics, and existing visual design guidelines from the previous literatures. At the same time, we conducted observation and ethnographic interview with a number of dyslexic children. Secondly, we modeled the users by using personification method and thirdly, we elicited the requirements and technical needs using scenarios. The crucial information gained from this stage were then added into the existing visual guideline. A detail discussion of the methodology is presented in [11]. The customized guideline is summarized in Table 1.

TABLE I  
IXD GUIDELINES FOR DYSLEXIC CHILDREN

Dimension	Element	Suitable Style
FORM	1. Typography	-Use a plain sans serif fonts such as Arial, Comic Sans, Verdana, Tahoma, Century Gothic, Trebuchet, Helvetica, dan Sassoon. -Font size should be 12-14 point. Some dyslexic reader need larger font. -Avoid using animated text. -Avoid light-coloured text on a dark background. The reverse is clearer. -use carefully selected font type that don't mirror.*
	2. Colour	-Avoid using green & red colour since they lead to distraction (especially to those who are colour blind). -Use the background colour suggested by dyslexia experts: (colour code: #FF3E2, #A4D5A6, #CCE685, #A8E685, #DED8E4, #87AA74, #9E9E7C, #F19D3B)*
	3. Layout	-Use left justified with ragged right edge. -Avoid narrow columns (as used in newspapers) -Lines should not be too long: 60 to 70 characters. -Avoid cramping material and using long, dense paragraphs: space it out -Line spacing of 1.5 point is preferable. -Avoid starting a sentence at the end of the line. -Use bullet point or numbering rather than continuous prose.
	4. Heading & Emphasis	-Avoid underlining and italics: these tend to make the text appear to run together. Use bold instead. -Avoid text in block capitals: this is much harder to read. -For headings, use larger font size in bold, lower case. -Use boxes for effective emphasis.
CONTENT	5. Screen	-The screen must be clean and tidy. -The screen should be designed with focus to the assignment.*
	6. Text	-Should have reading marker for word by word eg. pen animation* -The text should be bite-sized to help DC to read and understand.. -Should have a list of structured word. -Avoid using capital letters.
	7. Graphics	-Use graphic, images, photos to increase their understanding. -Avoid text in images.
BEHAVIOR	8. Audio	-Provide audio output e.g: narrator voice.
	9. Navigation	-Simple navigation.* -Navigation through picture. -Provide bookmark features.
	10. Choices	-Adjustable font types and sizes. -Adjustable font colour and background colour. -Adjustable <i>line spacing</i> dan <i>line length</i> . -Users are given opportunity to listen to feedback again or to repeat the same activity.* -Users are free to choose a list of words that is suitable to his/her reading level.
	11. Help	-Voice-based help menu (audio help). -An option could be provided to record user's progress.

\* Notes that the style of the elements are obtained through our observation and interview, which are added to the guideline to emphasize their importance to produce a good design for dyslexic children, with regard to their reading difficulties [11].

As denoted in Table 1, all three dimensions are covered. The form dimension lists five elements with their specific design styles – typography, colour, layout, heading and emphasis, and screen. The content dimension comes with

three elements and design styles – text, graphics, and audio. The behaviour dimension also encompasses three elements together with their suitable styles – navigation, choices, and help. We suggest that all the specified elements for the three dimension should be considered when designing for an

interactive application for dyslexic children reading to ease them and lessen their cognitive load when trying to read. Therefore, the next section presents an example of the translation of the design guidelines into a working prototype of a reading application for dyslexic children.

### III. THE GUIDELINE TRANSLATION

Prior to developing the prototype, the design guideline as presented in the previous section is first established. This is done by adopting the first three activities in Goal Directed Design (GDD) [8] as reflected in Fig. 3. Thus, to achieve the aim of this paper, the following three activities are continued from designing a framework) to implementing design refinement towards providing support by means of prototyping.

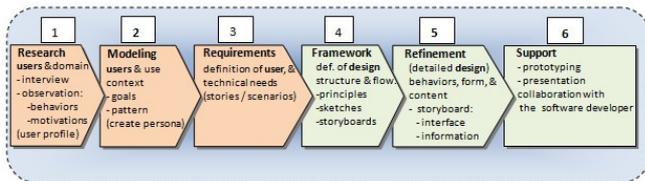


Fig. 3. The Goal-Directed Design methodology is used where the first three parts contributes to the design guideline. The last three parts concerns with the translation of the requirements, i.e. the guideline, into a reading application prototype.

The process of translating the guidelines into a prototype is done in the design framework phase. Here, a rough or initial design is used to describe how the persona interacts with the product by using storyboarding based on the requirements or guidelines that have been proposed. Generally, a low fidelity storyboard is used to save time and cost. In this phase, the interface is sketched and the interactions are designed. Normally, many sketches of design and interactions are produced at this stage in order to find the one that suits the application. Fig. 4 illustrates the sketches made for the IxD of this application. Critical interactions, anatomy and how it all fits together are put to focus.

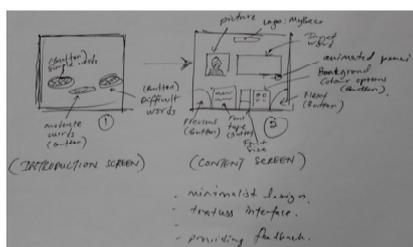


Fig.4. The example of the design sketches. They depict the interface of the reading application prototype.

To create a simple but good user experience is something that should not be taken lightly especially when designing for users with specific difficulties. In case of designing for dyslexic children whose reading are their difficulties, elements that could reduce their difficulties in reading need to be incorporated into the design. Therefore in design refinement phase, the detailed design in the form of the IxD dimensions - form, content, and behaviour, need to be carefully specified and refined as illustrated in Fig.5. The correct composition and organization of these three IxD dimensions can help to produce positive affect and emotional feedback from the users [12].

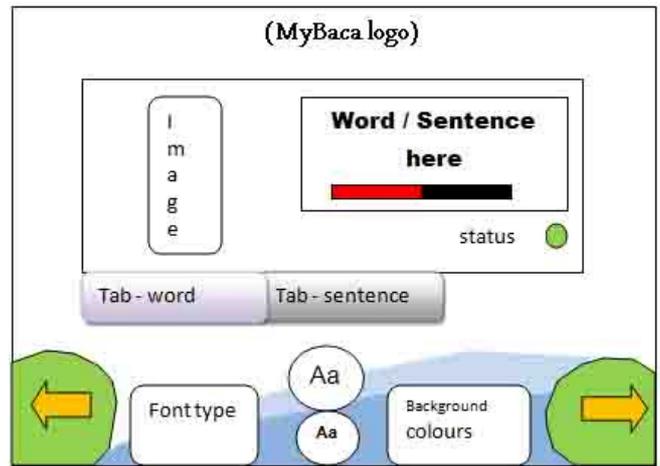


Fig.5. The example of the refined design. It incorporates the form, content, and behavior dimension of IxD.

### IV. READING APPLICATION PROTOTYPE

The reading application is developed for Malay language where it involves only isolated words, which is suitable for dyslexic children who are at early reading level. It involves word reading that covers from easy and moderate to difficult words. Words like *aku*, *itu*, and *ada* are included in the easy category, where words like *kangkung*, *pinggang*, and *jengking* are included in the moderate category. The difficult category includes words like *perangai*, *meringai*, and *jerangau*. The difficulty levels are determined based on the combination of vowel and consonant in a syllable and a word. Sentence reading is also included and also involves easy, moderate, and difficult sentences (e.g. easy – *itu rumah*; moderate – *saya makan kangkung*; difficult – *abang pergi memancing*). These are regarded as content in the IxD dimension that will trigger interaction from user of the application or prototype. The sample of the interface is shown in Fig. 6.

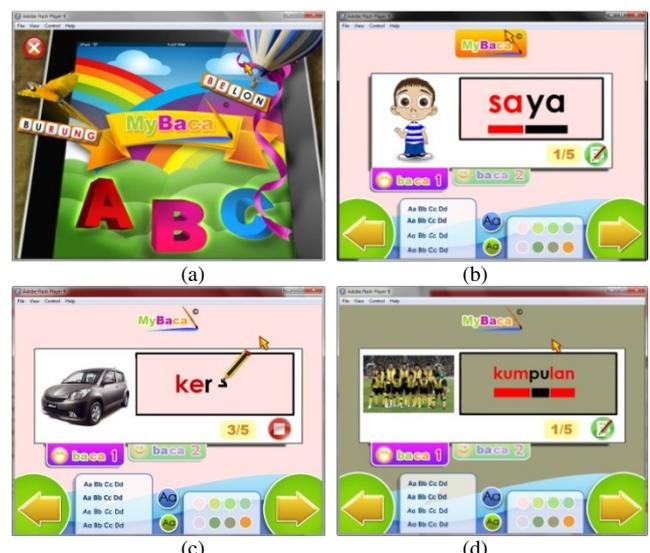


Fig.6. (a) The introduction page; (b) Simple word; (c) pencil animation; and (d) showing the background colour changeability.

From Fig.6, we can see that the prototype was designed with emphasizes on minimalist design. To reduce or lessen the dyslexic children's cognitive load while reading, minimalist design encapsulates a textless interface so that the children can only focus on the text that they have to read. Animated

pencil is also provided to animatedly show how a letter is written and a word is pronounced.

#### V. FUTURE WORK AND CONCLUSION

The main point of the paper is to show the process of (1) customizing IxD guidelines in order to assist dyslexic children reading in Bahasa Melayu; (2) translating the design guidelines into the prototype of reading application specifically for such user group. The importance of the work is to provide a way to design an application that caters the needs of a specific users. For the future work, the prototype will be used in an evaluation process with real users in order to determine its usefulness. The procedure will also include the use of eye tracking analysis and heatmap data collection while the participants are interacting with the prototype.

#### REFERENCES

- [1] J. Lerner, *Learning Disabilities: Theories, Diagnosis, and Teaching Strategies* (7th ed.). Boston: Houghton Mifflin Company, 1997.
- [2] R. K. Olson, & B. W. Wise, "Reading on the Computer with Orthographic and Speech Feedback: an Overview of the Colorado Remediation Project," *Reading and Writing: An Interdisciplinary Journal*, vol. 4, pp. 107-144, 1992.
- [3] S. Shaywitz, *Overcoming Dyslexia : a New and Complete Science-Based Program for Reading Problems at Any Level*. New York: Random House, 2003.
- [4] A. Fawcett, and R. Nicolson, "Dyslexia: the role of the cerebellum," in *Dyslexia: Theory and Good Practice*. London: Whurr, 2001.
- [5] N. Brunswick, "Explicit and Implicit Processing of Words and Pseudowords by Adult Developmental Dyslexics. A Search for Wernicke's Wortschatz?," in *Brain*, 122, 1999, pp. 1901-17.
- [6] M. Wolf, and R. Garzia, "Optometric Factors in Reading Disability," in *Visual Processes in Reading and Reading Disabilities*. NJ: Lawrence Erlbaum, 1993.
- [7] *About interaction design*, (2008, Jan. 25), Interaction Design Association,[Online]. Available: [http://ixda.org/about\\_interaction.php](http://ixda.org/about_interaction.php)
- [8] A. Cooper, R. Reimann, and D. Cronin, *About Face 3: the Essentials of Interaction Design*. Indianapolis: Wiley Publishing, 2007.
- [9] J. A. Russell, "Core Affect and the Psychological Construction of Emotion," *Psychological Review* , 110 (1), pp. 145-172, 2003.
- [10] *Supporting Literacy with ICT*, (2009, Nov. 4), British Dyslexia Association,[Online]. Available: <http://www.bdadyslexia.org.uk/about-dyslexia/it-information/supporting-literacy-with-ict.html>
- [11] A. A. Fakhrol and H. Husniza, "Interaction Design for Dyslexic Children Reading Application: A Guideline," in *Proc. Knowledge Management International Conference*, Johor Bahru, 2012, pp. 693-698.
- [12] J. Tidwell, *Designing Interfaces: Patterns for Effective Interaction Design*. Sebastopol: O'Reilly Media, 2006.