

# Interaction Design for Dyslexic Children Reading Application: A Guideline

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## ABSTRACT

This paper outlines and explains the guideline needed to design an effective interaction design (IxD) for dyslexic children's reading application. The guideline is developed based on theories that underly dyslexia and its effects towards reading, with emphasis given to the visual related theories and phonological deficit theory and core-affect theory. The needs of a dyslexic child to read properly and correctly with understanding of the related theories inspires the development of this guideline as it is aimed to aid the process of learning to read by facilitating them with useful design. Tested on a number of dyslexic children, the design seems to reduce their memory load for this particular task and thus reduce their difficulties in reading. Hence the role of an interaction designer is needed to answer the whats and hows and to design an interactive product (in this case – reading applications) to help dyslexic children to read.

**Keywords:** *interaction design, dyslexia, reading application.*

## I INTRODUCTION

Dyslexic children (DC) are usually associated with the phonological deficits that interfere with their progress in reading skills. For them, reading and spelling is a difficult process, not exciting, and most of the time exhausting. Poor concentration also caused them to try to avoid learning to read and spell out words, even for simple words. However, it does not mean they have lower IQ levels than normal children. Dyslexic children usually have an IQ level equivalent to normal children and higher. This fact shows that the dyslexic children actually have the potential to succeed if given the right help early.

It is where computer-based reading application, more specifically the ones that are specifically built for them to cater their needs, is viewed as one of the many tools that could reduce their difficulties

as it could provide the power of physical assistance such through interaction design (IxD). As a physical help, reading application for dyslexic children is essential to help them to read successfully as many researches have found that computers could help improve the performance of dyslexic children in reading (Conn & McTear, 2000; Dwyer, 2000; Higgins, 2004; Higgins & Raskind, 2000; Lundberg, 1995; Olofsson, 1992; Olson & Wise, 1992; Raskind & Higgins, 1999; Raskind & Shaw, 1999). However, none of the reported studies emphasize on the design of such application that is specifically developed to accommodate reading difficulties of dyslexic children. Since dyslexic children's difficulties in reading is attributed by various theories such as phonological and visual deficits, it can be argued that a careful and specific design should be developed based on the theories in order to reduce their difficulties. Hence, certain aspects of IxD should be taken into account in order to materialized a dyslexic-friendly any reading based application, such as an automatic reading tutor's interface, that could actually facilitate them in learning to read.

## II INTERACTION DESIGN

IxD is a field that touches on design for user experience (UX). However, it is more focused on complex dialogue between a human and an interactive devices, in this case a computer (Interaction Design Association, 2008). It has three dimensions – form, content, and behaviour depicted in Figure 1.

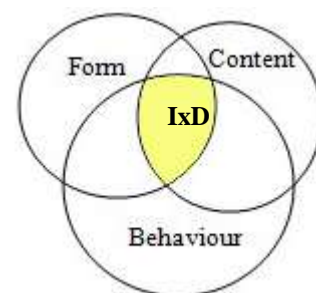


Figure 1. IxD dimensions.

A good design often brings out positive feelings to users (Cooper, Reimann, & Cronin, 2007). It is inline with core affect theory (Russell, 2003) that suggested 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.

### III METHODOLOGY

To develop the guideline, the following activities with specific methods have been conducted: user research, user modeling, and requirement analysis (through scenario). Prior to these activities, library search about general dyslexic children's

characteristics have been performed in relation to the related theories as mentioned. These activities have been conducted in order to obtain significant characteristics of dyslexic children in order to produce and set guideline to help designers design an effective IxD for dyslexic children's reading.

#### A. User Research

A number of 10 dyslexic children, aged between 10 to 13 years old, are randomly selected to participate in the study. Most of them are from middle class family whose parents are mostly self employed. The study was conducted in a public primary school that offers special dyslexia classes for the children. We have done ethnographic interview and observation to a group of DC. The activities depicted in the photos as in Figure 2.



Figure 2(a). Ethnographic interview



Figure 2(b). Observation

Then the user profiles is build as a result from the informal interview. To obtain information about the participants' background and behaviours, interview and observation were carried out. The interview was conducted in an informal manner. The interview session was held individually for each of the participants. Questions asked in the interview

are personal questions such as favourite colours and food and emotionally related questions. These questions are viewed as necessary by the researcher in order to elicit the children's characteristics in which the requirements for a suitable, well-tuned reading application for dyslexic children shall be indirectly extracted. All participants are required to

answer all questions within their own time. While interviewing, the participants are being simultaneously observed for a closer look at their characters which is reflected in the way they speak and deliver themselves. Their characteristics observed are also recorded for further analysis. Apart from that, their response during using a computer application also been observed and recorded.

### B. User Modeling

In order to model the user, we created the primary persona. This is done by using the user profiles collected in A. Table 1 illustrates the findings of data collection process that produced vital information of each participant for further analysis, which obtained from individual interview and observation session. This also called the user profiles.

Once the data have been successfully gathered and tabled accordingly, the information contained serve as point of analysis. Data analysis is conducted to obtain significant characteristics to be included as persona. Two phases involved include creating the participants' profiles and creating personas before primary persona can be chosen. The primary persona, which represents the dominant group of dyslexic children, is used for comparing features the ideal features of a reading application meant for the children as in Figure 3.

As mentioned, persona represents a fictional individual that represents collective needs and requirements of specific users for a particular computer application. Creating personas involving creative synthesis process and an in depth analysis of profiles created to represent users (Zhang, & Li, 2005). Figure 4 depicted the persona which created after the profiling and behaviour grouping process.

Table 1. User Profiles

Res.	Characteristics									
	Age	Fav. Colour	Character	Interest in Reading	Fav. Cartoon	Pet	Gaming	Means to School	School Attendance	Handling Sadness
1	11	Purple	Talkative	Like	Mr. Bean	No	No	Car	Seldom absent	Be quiet
2	13	Blue	Talkative	Dislike	Mr. Bean	Dog	Yes	Car	3x absent	Throw things
3	10	Green	Talkative	Like	Ben 10	Cat	Yes	Car	Full	Watch TV
4	9	Red	Talkative	A little	Jacky Chan	Fish	Yes	Walk	Full	Be quiet
5	11	Black	Courteous	Dislike	Phineas & Ferb	Tortoise	Yes	Car	Full	Be quiet
6	11	Blue	Courteous	Like	Tom & Jerry	No	Yes	Car	2x absent	Be quiet
7	10	Red	Courteous	Like	Doraemon	Cat	No	Car	Seldom absent	Be quiet
8	11	Pink	Talkative	Like	No	No	Yes	Car	1x absent	Be quiet
9	13	Blue	Talkative	Like	Naruto	Tortoise	Yes	Car	Full	Be quiet
10	10	Blue	Courteous	Dislike	Kid's Next Door	Cat	Yes	Car	Seldom absent	Be quiet

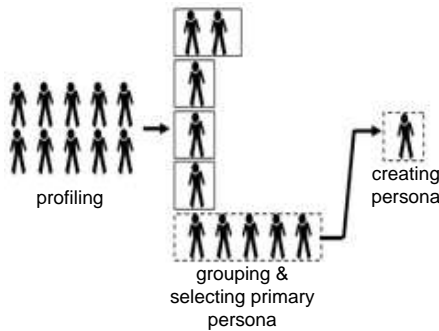


Figure 3. Process of filtering similar profiles

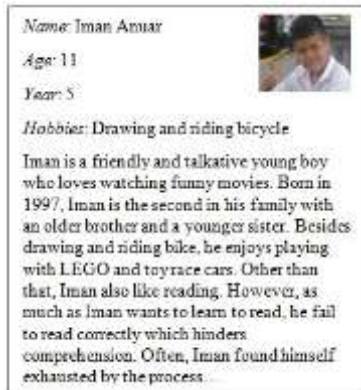


Figure 4. Example of a persona

Referring to Figure 4, persona is useful in any application design to deal with the diversities of user requirements. Using affective quality elicited from persona, the design of such application can be done to cater for the needs of other people that share similar needs as the target users (Cooper, Reimann, & Cronin, 2007).

### C. Requirements / Guideline

The primary persona is used to elicit the user requirements based on data obtained from the study.

Reference is also made from literature study related to reading application interface for dyslexic children. Next, these findings are combined to form the guideline as depicted in Table 2. The guideline encompasses three IxD dimensions – form, content, and behaviour. The findings obtained through this research are marked with \* symbols at the end of the descriptions of styles.

## IV DISCUSSION

Referring to Table 1, the three IxD dimensions, form, content, and behaviour, with their corresponding design characteristics are outlined. This includes the individual elements of each dimensions that should be incorporated into any design meant for dyslexic children's reading.

The form dimension has been given more emphasis to compensate the visual processing deficits of

dyslexic children. Hence, more IxD elements are outlined with their corresponding design characteristics specifically to cater for dyslexic children's needs. These elements such as typography, colour, and layout are all set based on findings and literature study. For example, the form dimension specifies that only plain sans serif fonts should be used as it is found that dyslexic children are having difficulties reading with serif fonts. Instead, the sans serif fonts are easier for them to identify the letters and thus spell and read. Interestingly, given the suitable visual aid such as fonts and background colours, they can actually read.

As for the phonological deficit, the content and behaviour dimensions could be designed as suggested in the guideline to help them read. For example, the help element in behaviour dimension and the audio element in the content dimension suggest that help or feedback should be given using voice (text-to-speech technology) as it would facilitate them to listen to the correct reading and try to produce the same correct pronunciation/reading later. This way, their difficulties in phonological processing could be assisted by giving them immediate, audio feedback and help so they can self-correct their reading accordingly.

Table 2. The guideline with IxD dimensions and their elements

Dimension	Element	Suitable Style for DC
FORM	1. Typography	-Use a plain sans serif such as Arial, Comic Sans Verdana, Tahoma, Century Gothic, Trebuchet, Helvetica, dan Sassoon. -Font size should be 12-14 point. Some dyslexic reader need a 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 e.g: b & d.*
	2. Colour	-Avoid using green & red colour since they lead to distraction (especially to the blind colour people). -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.
	5. Screen	-The screen must be clean and tidy, and focus to the assignment.*
CONTENT	5. 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.
	8. Audio	-Provide audio output e.g: narrator voice.
BEHAVIOUR	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 users progress.

## V CONCLUSION

This paper proposes a guideline for developing an interactive reading application, such as an automatic reading tutor, that employs IxD to enhance interactivity between dyslexic children and the application. The guideline encompasses three dimensions of IxD, which are the form, the content, and the behaviour of an application. The form dimension outlines requirements to compensate visual processing deficits of dyslexic children in reading whereas the phonological deficit could be compensated using the content and behaviour dimensions, for example using voice instead of text-based feedback/help. This paper highlights the findings as a guideline to design such application to facilitate dyslexic children's reading aiming towards a more dyslexic-friendly application.

## REFERENCES

Conn, N., & McTear, M. (2000). Speech technology: A solution for people with disabilities. *IEEE Seminar on Speech and Language Processing for Disabled and Elderly People*, 7, London, UK, 1-6.

- Cooper, A., Reiman, R. and Cronin, D. (2007). *About face: The essentials of interaction design* (3<sup>rd</sup> ed.). Indianapolis: John Wiley.
- Courage, C. and Baxter, K. (2005). *Understanding your users: A practical guide to user requirements*. San Francisco: Morgan Kaufmann Publishers.
- Dwyer, B. (2000). *The uses of computer technology in the remediation of children with specific learning difficulties (Dyslexia)*. Retrieved Mar 28, 2007, from <http://webpages.dcu.ie/~farrenm/spec.pdf>
- Higgins, E. L. (2004). Speech recognition-based and automaticity programs to help students with severe reading and spelling problems. *Annals of Dyslexia*, 54, 365 - 392.
- Higgins, E. L., & Raskind, M. H. (2000). Speaking to read: The effects of continuous vs. discrete speech recognition systems on the reading and spelling of children with learning disabilities. *Journal of Special Education Technology*, 15, 19 - 30.
- Interaction Design Association. (2008). *About interaction design*. Retrieved Januari 25, 2008, from [http://ixda.org/about\\_interaction.php](http://ixda.org/about_interaction.php)
- Lundberg, I. (1995). The computer as a tool of remediation in the education of students with reading disabilities: A theory-based approach. *Learning Disability Quarterly*, 18(2), 88-99.
- Olofsson, A. (1992). Synthetic speech and computer aided reading for reading disabled children. *Reading and Writing: An Interdisciplinary Journal*, 4, 165-178.
- Olson, R. K. & Wise, B. W. (1992). Reading on the computer with orthographic and speech feedback: An overview of the Colorado remediation project. *Reading and Writing: An Interdisciplinary Journal*, 4, 107-144.
- Raskind, M. H., & Higgins, E. L. (1999). Speaking to read: The effects of speech recognition technology on the reading and spelling performance of children with learning disabilities. *Annals of Dyslexia*, 49, 251 - 281.
- Raskind, M. H., & Shaw, T. (1999). Assistive technology for individuals with learning disabilities. *Proceedings of Technology and Persons with Disabilities Conference 1999*. Retrieved Mar 9, 2007, from <http://www.csun.edu/cod/conf/1999/proceedings/session1002.htm>
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, 110(1), 145-172. doi:10.1037/0033-295X.110.1.145
- Snowling, M. J. (2000). *Dyslexia* (2<sup>nd</sup> ed.). Oxford, UK: Blackwell Publishers.
- Stanovich, K. E. and Seigel, L. D. (1994). Phenotypic performance profile of children with reading disability: A regression-based test of the phonological-core variable-difference model. *Journal of Educational Psychology* 86, 24-53.
- Vellutino, F. R., Fletcher, J. M., Snowling, M. J. and Scanlon, D. M. Specific Reading Disability (dyslexia): What we have learned in the past four decades? (2004). *Journal of Child Psychology and Psychiatry* 45, 1, 2-40.
- Vellutino, F. R., Scanlon, D. M. and Spearing, D. (1995). Semantic and phonological coding in poor and normal readers. *Journal of Experimental Child Psychology* 59, 76-123.
- Vellutino, F. R., Scanlon, D. M., Sipay, E. R., Small, S. G., Pratt, A., Chen, R. S. and Denckla, M. B. (1996). Cognitive profiles of difficult-to-remediate and readily remediate poor readers: Early intervention as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disability. *Journal of Educational Psychology* 88, 4, 601-638.
- Zhang, P. and Li, N. (2005). The importance of affective quality. *Communication of the ACM* 48, 9, 105-108.