Learners with Dyslexia: Exploring their experiences with different online reading affordances

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Abstract. To date, empirically derived guidelines for designing accessible online learning environments for learners with dyslexia are still scarce. This study aims to explore the learning experience of learners with dyslexia when reading passages using different online reading affordances to derive some guidelines for dyslexia-friendly online text. The study employed a multiple-case qualitative approach and key themes were interpreted based on these learners' perceived learning, engagement and satisfaction. The study concludes that the use of screen reader for online reading should be optional, adequate control of screen reader should be provided and screen reader is more beneficial when online text is written in a language that the learner is not proficient. Results from this study also provide empirical support of the appropriateness of some existing web accessibility guidelines.

Keywords: Dyslexia, online learning environments, screen reader

Introduction

Dyslexia is derived from Greek words of 'DYS' that means difficulty and 'LEXIA', which means words. It is a language-based learning disability in which individuals experience difficulty in phonological processing (Shaywitz et al., 2004; Snowling, 2009). Dyslexia can hinder a person's ability to perform language-related tasks such as word recognition or reading, writing, spelling, reading comprehension, and sometimes speaking (Washburn, Binks-Cantrell, & Joshi, 2014). However, dyslexia is not linked to low intelligence (Catts, 1996). It is also known not to be specific to English language only (Brunswick, 2010) although there is an increasing evidence showing that persons with dyslexia face more difficulties in learning to read English than other European orthographies (Seymour, Aro & Erksine, 2003).

It is estimated that as many as 15–20% of the school population (one out of five students) in the United States exhibit some symptoms of dyslexia (The International Dyslexia Association, 2012). Other studies on the prevalence of dyslexia reveal frequencies between 5% and 17.5% (Chan et al., 2007; Ong, 2009; Roongpraiwan et al., 2002; Shaywitz, 1998; Shaywitz, Gruen & Shaywitz; 2007; Silver, 1988). As such, being a significant minority, the learning needs of students with dyslexia cannot be ignored.

Literature review

Various computer-based interventions are found to yield benefits to phonological awareness, rapid naming, phonemic decoding, word reading accuracy/fluency, spelling, and reading comprehension for persons with dyslexia (Lynch, Fawcett & Nicolson, 2000; Saine et al., 2011; Torgesen et al., 2010). In addition to such computer-based intervention programs, some efforts are also made to gain better insights into experience of persons with

dyslexia on online Web materials as most designers understand that websites should be made accessible to all. With the ubiquitous use of online learning in education, more efforts need to be taken to enable learners with dyslexia to fully benefit from this mode of delivery. However, McCarthy and Swierenga (2010), who have done a research review on dyslexia and Web accessibility, conclude that there are only a handful of attempts to study web site accessibility among users with dyslexia despite the fact that nearly one-third of Internet users are diagnosed with dyslexia or possess some symptoms of dyslexia. Studies that specifically focus on accessibility to online learning platforms are even lesser, causing a greater concern as to whether learners with dyslexia could cope with the demands of such learning mode.

According to McCarthy and Swierenga (2010), web accessibility guidelines for dyslexic and other disabled users are derived by Bradford (as cited in McCarthy & Swierenga, 2010), Jiwnani (as cited in McCarthy & Swierenga, 2010), Nielsen (2005), Pearson and Koppi (2002), Phipps, Sutherland and Seale (2002) and Zarach (2002). Many of these guidelines are not based on empirical studies (McCarthy & Swierenga, 2010) and most of them are meant to accommodate all visual disabilities and not specifically meant to meet the needs of people with dyslexia (de Santana et al., 2012; McCarthy & Swierenga, 2010).

Research problem

The use of online learning is appropriate for learners with dyslexia as this delivery mode allows self-paced learning and affords multimodal technologies that have the potential to settle dominant deficit models of dyslexia (Moores, 2004). Nevertheless, a framework to explicitly guide the creation of a suitable online learning interface and the use of appropriate online instruction strategies that facilitate learners with dyslexia are still unavailable. According to Sloan (2002), it is vital to capitalize the potential of the Web for learning and teaching purposes and to increase its accessibility to widest possible audience. In addition, Sloan (2002) has provided a set of guidelines to create accessible e-learning content. However, these guidelines, once again, are not specifically meant for learners with dyslexia. These limitations in the existing guidelines further justify the need to derive a framework that specifically caters the requirements of learners with dyslexia when using online learning materials.

Aim

The aim of this study is to explore the learning experience of students with dyslexia when reading passages using three different online reading affordances to derive some guidelines for dyslexia-friendly online text.

Research questions

RQ1: How learners with dyslexia perceive their learning when using different online reading affordances?
RQ2: How engaged are learners with dyslexia with the different online reading affordances?
RQ3: How satisfied are learners with dyslexia with the different online reading affordances?

Significance of the study

Persons with dyslexia often face difficulties with written text on the web (de Santana et al., 2012). As web text is one of the extensively used elements in online learning, this study makes the initial effort by exploring experience of learners with dyslexia when using different online reading affordances. The phonological deficits of these learners create

reading difficulties and exploring their learning experience with diverse affordances helps to shed insight on the appropriate affordances that enable them to improve their reading and understanding of text-based online learning contents. Although studies, such as the recent one by Rello, Kanvinde and Baeza-Yates (2012), have produced some layout guidelines for web text, most existing guidelines for people with dyslexia are derived in western countries. Very few studies have been conducted in the eastern side of the world. This study focuses on students with dyslexia of an eastern country.

Methods

This study used a qualitative multiple-case study to discover learning experiences of students with dyslexia when using different online reading affordances. Twelve secondary school students with dyslexia, seven female and five male, with their ages ranging from 14 to 18 years old were involved. There were three Malays, three Chinese and six indigenous natives of Sarawak. All students were from middle socioeconomic families and studied at public day schools in Kuching, a city located in Sarawak, Malaysia. The researchers obtained their particulars from the Sarawak Education Department and these students were diagnosed with dyslexia by medical doctors. The researchers had also obtained permission to conduct this study from respective school principals of these students as well as obtained informed consent from each student.

Online reading affordances

This study involved the use of three types of online reading affordances, known as Control mode, Standard mode and Enhanced mode. Each mode consisted of a reading passage. Table 1 shows the differences and similarities between these modes. In the Control mode, the passage was presented using the layout and typefaces that are similar to those commonly found on a conventional printed book. In the Standard mode, the passage was presented based on some dyslexia-friendly text guidelines as suggested by The British Dyslexia Association (n.d.). Some of these guidelines are similar to the dyslexia-friendly text characteristics suggested in Plakopiti and Bellou (2014). The Enhanced mode used similar information presentation guidelines as in the Standard mode but with the addition of a screen reader.

Instruments

This study examined three aspects of learning experience, which include perceived learning, engagement and satisfaction. The study employed an interview guide (see Table 2). Questions in the interview guide were derived from the literature on these three aspects to ensure construct validity.

Table 1. Characteristics of Control, Standard and Enhanced modes

Control	Paragraph form, justified alignment, single spacing, serif font type, font size (12-14 point), black font on white background
Standard	Bulleted points, left justified, 1.5 line spacing, sans serif font type, font size (16-18 point), black font on beige background
Enhanced	Bulleted points, left justified, 1.5 line spacing, sans serif font type, font size (16-18 point), black font on beige background, screen reader

Table 2. Questions in the interview guide

Perceived Learning	- How much did you learn? - Do you think the quality of your learning has improved? - Do you think reading the passage broaden your knowledge? - Do you find it easy to read? - Do you find it easy to remember? - Do you think the passage is useful to your learning?
Engagement	Behavioral engagement - Do you have the tendency to stop half way while reading the passage? - Do you put your best effort to read through the passage to gain a better understanding? Cognitive engagement - Do you pay much attention to the passage? - Do you check whether you understand the passage? Affective engagement - Do you think learning is fun because you gain more knowledge through the passage? - Would you recommend the use of [each reading affordance] to your friend for online reading? - Do you enjoy reading the passage? - Do you think reading the passage is a waste of time? - Are you looking forward to using [each reading affordance] for reading a passage in your future studies?
Satisfaction	Willingness to focus when learning - Does the way the passage is presented attract you to focus on it? Management of emotions - Do you think reading the passage makes you nervous? - Do you think the passage make you feel uncomfortable/uneasy? - Do you think reading the passage let you feel psychological stress? Management of behavior - Do you think reading the passage makes you confused? - Do you think reading the passage needs a lot of patience? Perceived usefulness and ease of use - Do you find it easy to read the passage? - Do you think reading the passage is difficult/complicated? Learning motivation - Are you eager to understand about the content of the passage? - Do you think [specific features of each reading affordance] are useful in helping you to read? Learning interest - If you have another opportunity to read the passage using [each reading affordance], would you gladly do so?

Perceived learning or self-reports of learning is the amount of knowledge that students think they are gaining (Wighting, 2011). Perceived learning is considered as a valid measurement of learning as opposed to learning measured by grades or test results (Pace, 1990; Wighting, 2011). Questions to uncover participants' perceived learning include asking them how much they learned from their experience with the online learning (Rovai et al., 2009), how much they think their learning quality has improved (Wu & Hiltz, 2003), whether the experience contributes positively to learning (Koohang & Durante, 2003), whether the experience is helpful for learning (Wu & Hiltz, 2003), and whether the experience may compensate difficulties or enhance abilities (Koohang & Durante, 2003).

Engagement reflects a person's active involvement in a task or activity (Reeve et al., 2004) and specifically refers to attitudes, interest and self-efficacy in a particular learning situation (Reading, 2008). According to Fredericks, Blumenfeld and Paris (2004) and Jimerson, Campos and Greif (2003), there are three types of engagement: cognitive (investment in learning, self-regulation,); behavioral (positive conduct, participation); and affective (positive feelings, interest, belonging, valuing). Questions in the interview guide that examine cognitive engagement include asking participants on their level of attention which reflects the desire to learn (Fredericks et al., 2004; Miller, Rycek & Fritson, 2011, Reading, 2008) and self-regulated strategies used to learn (Appleton et al., 2006; Fredericks et al., 2004). As for the behavioral component, participants were asked in terms of their effort and persistence to pursuit learning goal (Appleton et al., 2006; Fredericks et al., 2004). In addition, observations were also made on participants' involvement and commitment (Appleton et al., 2006; Fredericks et al., 2004) to the learning task to gain more insights into their behavioral engagement. Questions on the affective component include asking them on their feelings, interest and how they value the experience (Appleton et al., 2006; Fredericks et al., 2004).

Satisfaction is one of the major aspects used to evaluate learning effect. Satisfaction is found to be positively affecting students' behavioral intention to participate in online learning and such behavioral intention is highly correlated with learning effectiveness (Liaw, 2008). Questions to reveal participants' satisfaction check whether the experience produces positive feelings and attitudes (Lee, 2008; Tough, 1982) which include willingness to focus when learning (Lee, 2008), management of emotions (Lee, 2008; Sun et al., 2008), management of behavior (Lee, 2008), perceived usefulness and ease of use (Arbaugh & Duray, 2002; Gardner & Amoroso, 2004; Isik, 2008; Sun et al., 2008; Wu et al., 2006), learning motivation (Lee, 2008), and learning interest (Lee, 2008).

Procedures

A pilot test involving a 15 year-old student with dyslexia was conducted prior to the actual evaluation sessions. Findings from this test led to some revisions to questions in the interview guide as well as tasks for the three different reading affordances to improve their clarity and comprehensibility. One of the major changes made to the reading passage was to produce another version using the national language as this pilot study revealed the difficulty of this participant to understand the passage in English. This reading passage, written in Malay language and the content on hobbies, was subsequently used in the actual evaluation sessions. Similar to the English language, the Malay language is also an alphabetical language.

Each participant was involved in three separate evaluation sessions consecutively. Each session was conducted by two researchers, one in-charge of interacting with the participant while the other one was to assist in taking notes, recording non-verbal information as well as controlling the video recorder. In the first evaluation, the participant was required to read a passage presented in the Control mode followed by an interview based on the questions in the interview guide. In the second evaluation, the participant was required to read another passage presented in the Standard mode and subsequently another passage in the Enhanced mode during the third evaluation session. An interview was conducted after the participants have gone through the passage reading using each mode. All interviews were video recorded, with the permission of participants being interviewed.

Table 3. Comparison of perceived learning between modes

	Control	Standard	Enhanced
Knowledge	Little	Much	Very much, much or little
Ease of reading and knowledge retention	Difficult	Easy - Keywords - Bulleted points - Font (16-18 pt)	Very easy, easy or difficult
Usefulness	Little	Much	Very much, much or little

Data Analysis

This study employed the iterative qualitative data analysis model as proposed by Gay and Airasian (2003). This iterative process involves the following steps: (i) familiarize with data and identify potential themes, (ii) provide detailed descriptions, (iii) code and categorize data into themes, and (iv) interpret and synthesize data into written conclusions.

The researchers transcribed the recorded interviews and cross-checked the transcript with video recordings in order to add pertinent non-verbal information. Three researchers independently analyzed data for each mode based on the three learning experience aspects, which are perceived learning, engagement and satisfaction. For each online reading mode, significant statements on each learning experience aspect were coded with a label and corresponding statements were coded with the same label. These labels were categorized into the three learning experience aspects. Then, the researchers chose an appropriate theme for labels for each aspect or category to summarize statements within a mode. The researchers discussed among themselves to reach consensus on any inconsistent interpretations. This organization of data into different modes and learning experience aspects has allowed a more effective comparison of the three online reading affordances.

Results and Discussion

The following subsections explain the results based on the data analysis for each aspect of learning experience. The researchers translated some of the quotations, which were originally verbalized in the participants' first language, into English.

Perceived Learning

The following describes the key concepts and themes for each reading mode. Table 3 summarizes how participants perceived their learning using each of these modes.

Control mode - Low learning quality

The results show that all participants perceived the amount of knowledge that they managed to gain via the control mode was little as compared to the two other modes. The experience with this mode did not contribute positively to their learning experience as they faced difficulty to comprehend and remember the passage. For example, one of the participants commented "I think this is hard to read and understand…I cannot remember anything". In comparison to the other two modes, all participants agreed that the control mode is least useful to their learning.

Most participants did not think the font size was inappropriate as fonts of 12-14 points were still legible. This is in line with the font size recommendation by Al-Wabil, Zaphiris and Wilson (2007) and British Dyslexia Association (n.d.). However, three participants expressed their problems with the font size. Example of the comments include "*Words are too small,*

difficult to read and learn…make mistakes when reading because font size is too small" and "Reading is difficult because small font size makes it hard to pronounce a word".

Standard mode - High learning quality

Results from the analysis show that all participants provided positive responses on this mode. They reported their ability to understand the passage and remember the content more easily as compared to the Control mode. The use of bulleted points and highlighted keywords may partly explain this perception. Some related comments from the participants include "*In point forms…easy to read. Keywords also useful. I can broaden my knowledge because can do self-reading*", "*Able to remember some of the main points*", "*Able to learn because main points are highlighted…easy to remember as well because of highlighted points*", "*Easy to find main points, hence able to increase my knowledge*", and "*Able to learn the most because easy to identify main points…arrangement of the passage is easy to read*".

The use of bulleted points seems to aid the participants' reading. This is in line with one of Sloan's (2002) accessibility guidelines, which recommends the breaking of text into lists or short paragraphs. A participant commented "*I read and stop*". Such pausing is most probably guided by the way the information is presented and assisted in understanding. The same participant, on the other hand, reported to have read the reading passage continuously in the Control mode (the passage was presented in paragraph form). This further strengthens the benefit of using bulleted points in aiding comprehension. As pointed out by Freire, Petrie and Power (2011), the third most frequent problem faced by web users with dyslexia was their difficulty to scan page for specific items due to lack of structural or visual aids that would highlight these items. Beacham (2002) also highlights the needs to communicate key points in his proposed guidelines for developing dyslexia-friendly learning materials. In the Standard mode, both bulleted points and highlighted keywords would serve as such aids.

Although many of the participants thought the font size used in the Control mode was acceptable, all of them agreed that the bigger font size used in this Standard mode (16-18 points) made reading easier. This echoes the findings of Rello et al. (2013) who, based on their empirical study on dyslexia-friendly Wikipedia, have recommended the use of 18 points font size when designing web text for readers with dyslexia. In another study on the accessibility of web text for people with dyslexia, Rello et al. (2012) found that even bigger font size (22-26 points) was preferred by users with dyslexia. Despite the difference in suggested size, it clearly reinforces the role of bigger font size in increasing text readability.

The results reveal that participants found this reading mode to be useful to their learning. Some of the reasons given include the ability to do self-reading, easier to follow, and the highlighted keywords ease their understanding. Self-pacing may also explain the ability of this reading affordance to aid in remembering the learning content. For example, a participant commented "*Easier to remember because [my] thinking process is slow" and another commented "Reading by myself helps me to remember better".*

When examining the effects of different media combinations on the learning of persons with dyslexia, Beacham and Alty (2006) have reported the highest increase in learning when text only presentation was used. This is in line with the perception of improved learning quality by all participants for this Standard mode as only text is presented in this mode. The reasons gathered through this study may also help to further explain Beacham and Alty's (2006) study results on the effectiveness of the text only presentation. According to Beacham and Alty (2006), the use of a single text modality reduces the possibility of split attention (Sweller, van Merrienboer & Paas, 1998) and consequently reduces the switching of code modalities and cognitive load. The unavailability of redundant information also allows persons with dyslexia to keep pace of their reading.

Enhanced mode – Mixed excellent, high and low learning quality

Four participants showed very strong preference towards the Enhanced mode although they reported the Standard mode to be acceptable to them. These participants believed that the availability of screen reader helped much in improving their reading, comprehension, retention and pronunciation. They also found this reading affordance to be most useful to their learning. Thus, these participants were categorized as having excellent learning quality with this mode. One of these participants commented "*Can understand and learn the most…easier to read because got audio. It broadens my knowledge due to better understanding. Most useful for learning…".* The other participant commented "*It improves my reading because the audio helps. Easier to understand and can remember better…the audio is most useful for unknown words as it helps to pronounce".*

Another three participants perceived their learning to have improved, as compared to the Standard mode, if they were asked to read passage in English and when they were given the control of the screen reader. Thus, these participants were categorized as having high learning quality with this mode. The remaining five participants who perceived better learning using the Standard mode were categorized as having low learning quality with the Enhanced mode. The reasons for their preference towards the Standard mode include (i) the audio produced by the screen reader was distracting, (ii) the default screen reading speed used in this study was too fast, and/or (iii) personal preference towards the Standard mode although the Enhanced mode was also acceptable.

The distraction caused by the screen reader can be associated with Dual Coding Theory (Paivio, 1990) and Cognitive Load Theory (Sweller, 1994). Generally, Dual Coding Theory posits that there are two independent information processing channels; the verbal channel processes information such as text and audio, and the visual channel processes information such as image and animations. The use of the verbal channel to process both text reading and listening to the screen reader may have overloaded this particular channel. The participants may also experience split attention between these two modalities (Sweller et al., 1998). In addition, the impairment in phonological processing (Joanisse et al., 2000; Laasonen et al., 2012; Ramus et al., 2013) and deficit in visuo-spatial attention (Vidyasagar & Pammer, 2010) as well as weaknesses in their short term memory (Laasonen et al., 2012; Ludwig et al., 2010; Perez et al., 2012; Trecy, Steve & Martine, 2013) limit the number of verbal items that persons with dyslexia can retain in memory. Thus, this may explain the reported distraction experienced by some participants when using the screen reader.

Learning styles seem to play an important role to justify participants' preferences. As shown by Beacham and Alty (2006) in their study, different media combinations yield different learning effects for learners of different learning styles. The VARK model (Fleming, 2001) defines learning style as an individual's preferred ways of gathering, organizing, and thinking about information and it focuses on perceptual modes. The acronym VARK stands for Visual (V), Aural (A), Read/Write (R), and Kinesthetic (K). Those who prefer the Enhanced mode are most probably auditory learners who learn best through listening (Leite, Svinicki & Shi, 2009) while those who prefer the Standard mode are most probably reading/writing preference learners. This possibly explains the third reason on personal preference.

Engagement

Table 4 summarizes participants' behavioral engagement (BE), cognitive engagement (CE) as well as affective engagement (AE) when experiencing each of these modes.

Table 4. Comparison of engagement (BE, CE, AE) between modes

	Control	Standard	Enhanced
BE			
- observation	- read attentively	- read attentively	- read attentively
- tendency to stop halfway	- yes for some	- no	- no
- put best effort	- yes	- yes	- yes
CE			
- pay much attention	- yes, white background posed problem for some	- yes	- yes, audio was distracting for some
- check understanding	- read repeatedly	- paused in reading	- repeated audio
AE	- confusing and boring	- satisfying and fun	- interesting, confident
			- worried, lost

Control mode – Mixed High and Moderate BE

The observations made during the study reveal that all participants read the passage attentively with almost half of them read out the passage softly. All of them self-reported that they put their best effort to understand the passage. Only three participants reported their tendency to stop half way while reading the passage mainly due to small font size and difficulty to identify main points. Thus, this Control mode has yielded high BE among most participants and moderate BE among some others. Moderately engaged participants read attentively but faced the tendency to stop half way.

Control mode – Mixed Moderate and Low CE

When asked about how much attention was put for this task, most participants did not report any problem in paying attention except for two of the participants who earlier on reported perceived learning as occurred the most through the Enhanced mode (see Section 4.1.3) made the following comments respectively: "*I cannot pay attention" and "Words move…cannot read on white screen…make my eyes painful and tired"*. These participants were categorized as having low CE.

This is consistent with the study done by Freire et al. (2011) in which many web users with dyslexia in their study encountered problems with black writing on white background as the text forms 'visual patterns' or 'dancing around'. The impaired development of the magnocellular component of the visual system among many people with dyslexia, which is crucial in controlling eye movements, explains this unsteady vision (Stein, Richardson & Fowler, 2000). Gregor et al. (2003) report similar finding in which black on white setting caused their study participants to experience visual stress and lost. Using the combination of black on white produces high contrast and is not recommended for persons with dyslexia (Beacham, 2002; Rello et al., 2012) as some of them are sensitive to color and brightness (Jeanes et al., 1997). This phenomenon distracts attention.

Half of the participants reported that they faced difficulties to understand the passage although they were able to pay attention. Participants also self-reported that they checked their understanding of the passage by reading it repeatedly and/or paused frequently while reading. According to Beacham (2002), persons with dyslexia tend to re-read computer-based textual learning materials to allow context to aid decoding and thereby to increase understanding (Fidler & Everatt, 2012).

Control mode – Low AE (confusing and boring)

Generally, participants reported this Control mode as confusing. Passage presented in such format did not seem to aid understanding and repeated reading of long paragraphs were considered as wasting their time and needed a lot of patience. Although most participants did think reading using computer was fun, this Control mode was viewed as uninteresting and boring.

Standard mode – High BE

Similar to the Control mode, all participants were also observed to read the passage attentively with almost half of them uttered the passage softly. All of them were observed as well as self-reported that they did not have the tendency to stop half way while reading the passage and put their best effort to understand the passage. Thus, this Standard mode has also yielded high behavioral engagement among participants.

Standard mode – High CE

All participants were able to pay attention to the passage. Several participants reported that they paused in between reading to check their understanding. The use of bulleted points most probably guided the read-pause pattern of these participants. Eye tracking study by Schneps et al. (2013) demonstrated that short lines, as with the use of bulleted points as oppose to lengthy paragraph form, facilitate reading for persons with dyslexia by guiding visual attention to the uncrowded span.

Standard mode – High AE (satisfying and fun)

None of the participants reported negative emotion after experiencing the Standard mode. Some sample comments include "*I have the most fun reading using this…would introduce to friends and use again in the future*", "*Enjoy reading this passage…I like reading quietly*", and "*Learning is fun because I can remember what I read*". Generally, they were satisfied with this experience and found it to be interesting and enjoyable.

Enhanced mode – High BE

As with the Control and Standard mode, all participants were also observed to listen and read the passage attentively with almost half of them read out the passage softly. All of them were observed as well as self-reported that they did not have the tendency to stop half way while reading the passage and put their best effort to understand the passage. Thus, this Enhanced mode is interpreted as also yielded high behavioral engagement among participants.

Enhanced mode – Mixed High and Low CE

Most participants were able to pay attention to this reading mode. A participant commented "Screen reader acts as a person reading for me…this makes it more attractive and easier to concentrate". However, four participants reported the use of audio or screen reader distracted their reading. This echoes the study by Elkind, Cohen and Murray (1993) which reports 14% of their study participants showed lower comprehension scores when using computer reader to aid their reading although majority of their participants benefited from this reader. All participants were observed to repeat the audio to ensure their understanding.

Enhanced mode – Mixed High (interesting, confident) AE and Low (worried, lost)

All participants reported the Enhanced mode as interesting, exciting and fun. This mode also gave more confidence to some of them. Some of the comments include "*Most fun…will introduce to my friends as I think they will also like this because they are lazy to read*", "*It also gave more confidence and I will use it in the future*", "*I felt relieved because computer reads for me*", "*I do not feel so lonely when reading with the screen reader*". Nevertheless, some participants felt worried and lost when they were not given the option to control the reading speed and play/pause function. Examples of the comments include "*The computer reads too fast…I am lost*", and "*Screen reader promotes better learning when suitable speed is used. If speed is too slow, the audio becomes a disturbance*". This finding points to the importance of providing adequate control to the learner when using a screen reader.

Satisfaction

Control mode – Mixed Moderate and Low satisfaction

A number of participants regarded this Control mode as unattractive. Sample comments include "The passage is lengthy…small font, unattractive color and boring" and "Design looks boring and words are too small". Some also thought the passage made them nervous, confused, uncomfortable, and the passage was perceived as difficult to read. Among the reasons given include "Words move around makes me feel nervous" and "Difficult to read because black on white" which are related to the use of black font on white background as well as "Very lengthy… need to read and stop frequently"," I feel lost because of long sentences", "I am scared of reading wrongly" and "Confused and stressed in identifying main points", which are related to the use of paragraph form. However, half of the participants reported this reading mode as not causing any discomfort, confusion and anxiety to them. Familiarity to such information presentation, which is often found on typical printed books, may explain their positive emotion and behavior towards this mode.

Standard mode – High satisfaction

All participants reported satisfaction towards this reading mode. The reading passage was able to attract them to focus on it. They also did not experience nervousness and discomfort during the reading experience. Some of the comments include "I feel comfortable because can read myself" and "Easy to follow".

Participants also reported their reading as not difficult due to bigger font size, highlighted keywords and the absence of 'dancing words'. The passage for this Standard mode was presented using black text on beige background, which produces lower contrast comparing to the black on white setting used in the Control mode. This finding further supports earlier work such as Gregor et al. (2003) who reported higher reading comfort for persons with dyslexia when reading using settings that have lower contrast both in luminance and color.

Enhanced mode – Mixed Excellent, High and Low satisfaction

Four participants reported excellent satisfaction towards the Enhanced mode. As compared to the Control and Standard modes, these participants made a firm preference towards the Enhanced mode. The screen reader was regarded as successfully attracted them to focus on the passage. The screen reader did not cause them to feel nervous, discomfort or confused but rather eased their reading and understanding. A participant commented "*The sound helps me in remembering the passage…it is easiest to read with screen reader…easy to follow through the passage without the need to stop*". Screen reader is an assistive technology tool recommended to help individuals who struggle with reading as it facilitates decoding, reading fluency, and comprehension (GreatSchools, 2008; Shaywitz, & Shaywitz, 2012). This tool accesses the

listening capability of a person with dyslexia and enables him/her to gain knowledge from an auxiliary source (Shaywitz & Shaywitz, 2012). Elkind et al. (1993) who studied on computer-based readers found that 70% of 28 middle school students with dyslexia read with greater comprehension when using such readers and concluded that computer readers are important compensatory aids that enable students with dyslexia to perform more effectively in reading-related tasks.

Analysis of data also revealed another subgroup of participants who were classified as having high satisfaction. Two participants, who generally preferred the Standard mode, opted for the Enhanced mode if the reading passage was presented in English, a language in which they were not proficient. These two participants highlighted the benefit of the screen reader in aiding their understanding of the English passage compared with self-reading. According to Freire et al. (2011), unable to make sense of language is one of the problems reported by web users with dyslexia. Thus, the results from this study point to the potential of the screen reader in alleviating this problem.

Another participant chose this Enhanced mode over the Standard mode only when she was given the option to control the reading speed and play/pause function of the screen reader. As shown in the experiment by Stenneken et al. (2011), the reduced attention span of the group with dyslexia is due to the slowing of the visual perceptual processing speed. The speed of reading the passage, which involves visual perceptual processing, needs to be coherent with the audio processing. Giving screen reader control option enables the speed for both processing to be adjusted accordingly.

Generally, those who were satisfied with the Enhanced mode thought the audio attracted their attention and helped much in their reading. The use of audio allows these participants to access knowledge using an auxiliary source via listening (Schoeberlein & Wang, 2009). Only four of the participants found the audio to be distracting while the rest thought the experience did not make them nervous, uncomfortable, and/or confused. Those who found the audio as distracting are categorized as having low satisfaction as they reported their incapability to cope with both reading and listening at the same time and would not opt for such reading affordance.

Summary of results

Table 5 summarizes the key themes derived from each reading affordance.

Referring to RQ1, the results show that learners with dyslexia perceived low learning quality with Control mode but high learning quality with Standard mode. On the other hand, the Enhanced mode did not yield a single common agreement among all participants on this aspect. A group of them perceived excellent learning quality due to the use of screen reader. On the other hand, another group reported the screen reader as distracting.

Table 5. Key themes for Control, Standard and Enhanced modes

	Control	Standard	Enhanced
Perceived learning	Low	High	Mixed Excellent, High and Low
Behavioral engagement	Mixed High and Moderate	High	High
Cognitive engagement	Mixed Moderate and Low	High	Mixed High and Low
Affective engagement	Low	High	Mixed High and Low
Satisfaction	Mixed Moderate and Low	High	Mixed Excellent, High and Low

As for RQ2, all participants showed high behavioral engagement to all modes. The Standard mode produced consistent high cognitive and affective engagement as well as satisfaction among all participants. The Control mode is generally less engaging comparing to the Enhanced mode. Unlike the Enhanced mode, none of the participants were classified as having high cognitive and affective engagement as well as high satisfaction with the Control mode.

Implications

The results from this study provide a series of implications.

Empirical support for existing guidelines

As pointed out by McCarthy and Swierenga (2010), many existing web accessibility guidelines for users with dyslexia are not empirically derived. The perception of improved learning quality, high engagement and satisfaction towards the Standard mode, compared particularly to the Control mode, provides additional evidence on the appropriateness on some existing guidelines that were employed in the Standard mode. These guidelines include the use of bulleted points, left justified, 1.5 line spacing, sans serif font type, font size (16-18 point), and black font on beige background. On the other hand, the perception of low learning quality, less engaging and less satisfying findings for the Control mode further strengthens the inappropriateness of using lengthy paragraph, justified text alignment, single spacing, serif font type, and black font on white background for presenting web text. As this study was conducted on learners with dyslexia from an eastern country, results from this study also provide evidence on the relevance of the existing guidelines that are all derived in western countries to be used in this part of the world.

Screen reader is an excellent aid for some but not all

Many studies highlight the benefits that persons with dyslexia can gain from using screen readers (Balajthy, 2005; Bigham, Prince, & Ladner, 2008; Elkind, 1998; de Santana et al., 2012; Roberts et al., 2012). Results from these studies show that the use of a screen reader has yielded the perception of excellent learning quality, high engagement and excellent satisfaction among some participants, and suggest that this reader has indeed served as a great aid for these participants. However, the perception of distracted learning, less engaging and/or less preferred by some other participants also suggests that the use of screen reader may not be useful to all learners with dyslexia.

Screen reader aids language incompetence

The results of this study also reveal that the language proficiency level of learners with dyslexia affects their preference for screen reader. This study was conducted in a country where English is taught as second language or sometimes as third language. When participants were asked to read passages written in English, those who faced difficulties with the language found the screen reader to relieve their reading task and aid their comprehension. This suggests a context in which screen reader should be employed.

Screen reader control is crucial

The results from this study also point to the need to provide adequate screen reader control for learners, particularly for adjusting reading speed and play/pause functions. Low affective engagement was found on participants who needed such control to gain better reading and comprehension of the passage. This is in line with other initiatives to provide

highly customizable system to meet varying needs of different users with dyslexia such as those by deSantana et al. (2012) on Firefixia, Gregor et al. (2003) on SeeWord, Petrie, Weber, and Fisher (2005) on MultiReader, Rello and Baeza-Yates (2014) on DysWebxia as well as Topac (2012) on Text4All. Nevertheless, all these initiatives have yet to consider the inclusion of customization options for screen reader.

Online reading affordances guidelines

Based on the results, this study recommends (i) the use of screen reader for online reading should not be made compulsory but as an available option, (ii) adequate control for screen reader should be provided to learners, (iii) existing web accessibility guidelines (limited to those available in the Standard mode) are applicable and (iv) the use of screen reader if online text is written in a language that the learner is not proficient in.

Conclusion

This study has provided empirical evidence on the appropriateness for some of the existing web accessibility guidelines as well as their applicability to learners with dyslexia from the eastern culture. Although not conclusive, it has greatly contributed in identifying the affordances that are perceived positively by the learners with dyslexia, which may assist in the formulation of a more comprehensive guideline. It has also provided some recommendations to afford online reading. A very near future work is to compare the learning experiences of learners with dyslexia with the learning experience of normal learners to produce inclusive guidelines. So far, this work has mainly focused on online text presentation and delivery. Future studies may look into other aspects such as online web text navigation as well as plausible learning and teaching strategies (Rice & Greer, 2014) to aid online reading comprehension among learners with dyslexia. A correlational study between learning styles of learners with dyslexia and their learning experiences on these different reading affordances would also be insightful.

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