Using Eye Tracking to Investigate Malaysian ESL Students' Reading Processes and Preferences

THANG Siew Ming (tsm.2001uk@gmail.com)
HELP University, Kuala Lumpur, Malaysia
Noor Baizura Abdul Aziz (zura.aziz_155@yahoo.com)
Abedeen Academy, Cyberjaya, Malaysia

Abstract

The study was undertaken to investigate the effects of English as a Second Language (ESL) on students' reading processes and preferences on their comprehension of two different types of passages. The participants were 17 students from the English Language Studies department and 16 from the Psychology department of a public university in Malaysia. The eye tracker device (EyeNTNU-120) developed by the National Taiwan Normal University was used to record students' eye movements while reading the two different types of texts and their patterns analysed statistically. This was triangulated with interviews to find out students' preference and a reading test. A descriptive text (inclined towards language learning) and a comparison text (inclined towards psychology) were used. The interviews were undertaken to find out students' reading preferences and the reading test was to measure their reading comprehension performance. It was predicted that the ELS students would prefer Passage A and Psychology students would prefer Passage B because of familiarity of content materials. However, the results showed that both groups of students preferred Passage B and performed better for it too. The results further revealed that ge n e r a l l y both group of students exhibited similar patterns while reading and there was no relationship between reading patterns and reading comprehension scores. Finally, it was discovered that text-based reasons had a greater influence on passage preference than reader-based reasons.

Keywords: Eye-Tracking Research, Reading Processes, Reading Preferences, Schemata, Reading Performance

Introduction

Ramatu et. al. (2015) states that "reading is an indispensable tool in learning that forms an integral part of any learning situation, and the bedrock of education". According to Fielden (2004), a good reading habit will develop students' critical reflection in skills outcomes such as selecting, analysing, critiquing and synthesizing. Seeing how reading is such an important skill to possess, it can be assumed that an individual with good reading habits will have a better chance of succeeding in learning compared to those who have poor reading habits. However, factors that hinder effective reading and the development of good reading habits should also be considered. One such hinderance is poor presentation of text. For example, Ong (2011), through her study, found that students were more interested to read a newer

version of a text which had images and colour compared to a version which did not have such characteristics. Findings of Urquhart (1984) and Ibrahim & Ganayim (2013) came up with similar findings. Urquhart (1984) in his study on the effects of chronological and spatial ordering of texts on both native and non-native readers of English found that texts arranged in an orderly manner, according to a sequence of events, were read faster and were comprehended with greater ease than texts that had their temporal sequencing disturbed. His findings also revealed that texts with uniform spatial organisation were understood and remembered more easily. Ibrahim and Ganayim (2013) further discovered that text format had the ability to influence patterns of reading habits. In their research on Arabic texts, they manipulated interline spacings, columns and lines to create multiple text layouts. Their findings demonstrated that comprehension scores were better for single-column than multi-column setting.

What is the relevance of these findings to the Malaysian context? Several studies have been done in Malaysia in relation to how presentations of text influence reading behavior of undergraduates. Noorizah (2006) in her research on the reading processes of six Malaysian ESL learners, discovered that students regularly used various strategies to identify keywords or main points in the text. Noorizah (2006) as well as Wan Hurani and Anna Lynn (2009) concluded that the way texts were structured and phrased were important factors in influencing readers processing of learning. Zaira Abu Hasan (2008) in her thesis found that less proficient readers struggled to locate information from a reading text and were unable to engage critically or constructively to comprehend their readings. Thus, it is essential to identify the factors that deter students' access to texts and the problems they face in locating key points and supporting elements. This study is also interested to find out whether type of text, familiarity with the type of text and preference would affect reading speed and ease along with comprehension and memory of what is read.

To achieve the above objectives, this research study was designed to investigate how the preference of undergraduate students from a Malaysian public university on two reading passages that have the same level of readability would affect their comprehension performance. In addition to that, an eye tracking device was used to find out the students' reading patterns with emphasis on key and supporting elements present in the texts. The elements investigated were: (1) typographical features (TF), (2) structural features (SF) and (3) main points (MP). Typographical features (TF) function to introduce contents of a certain paragraph. Structural features (SF) indicate start of main points, introduction and elaboration to another point. Main points (MP) are key points of the passage. According to D' Ambrosio (2004), a good reader should be able to identify and focus on these important features when they are reading. The study was carried out on the university's English and Psychology undergraduates. Both groups of students were from the university's Faculty of Social Sciences. The following research questions were designed to address the objectives of the study:

1.   Do the participants' passage preferences match their comprehension performance?

2.   a) What do the eye tracking data reveal regarding reading patterns of ELS and Psychology students when reading these elements in Passages A and B?:

   i)   Typographical Features (TF)
   ii)   Structural Features (SF)

iii)   Main Points (MP)
 b) What is the relationship between reading patterns and reading comprehension scores of Passage A and B?

3.   What is the relationship between the participants' reading preferences and reading processes?

Conceptual Framework

The study draws upon the principles of two learning theories: Schema Theory and Cognitive Load Theory. Sir Frederick Charles Barlett (1868-1969), in the **Schema Theory**, proposes that individuals possess schemata which are also known as unconscious mental structures. These, represent an individual's experiences and general knowledge of the world. Presence of schemata, according to Barlett, impacts the formation of new information.

Barlett's work on schemata was the pioneer of many different researches in the field of background knowledge or schemata. Schemata can be divided into two: formal schema and content schema (Carrell & Eisterhold 1983). Zhu (2005) refers to Carrell & Eisterhold's formal schemata as the existing knowledge of rhetorical organizational structures of different types of texts. Meanwhile, content schemata refers to background knowledge related to content matter of the text. Carrell and Eisterhold (1983) further adds that the activation of appropriate types of schemata during processing is essential to ensure sufficient comprehension.

In the case of the **Cognitive Load Theory**, Sweller (1988) proposes that the process of learning happens best under conditions that are parallel with the human cognitive structures. Sweller's (1988) theory is based on George Miller's (1956) Information Processing Theory, which treats schema as the cognitive structures that builds up a person's knowledge base. While Miller's theory focuses on short-term memory and how it is limited in the number elements (or chunks) it can contain, Sweller, on the other hand, focuses on the contents of long-term memory which are the schemas.

For schema acquisition to occur, the information that is found in instructional materials must initially be processed by the working memory. From the instructional perspective it means that instructional materials should be designed in such a way that it reduces working memory load so that the maximum amount of information processing can occur (Sweller 1988).

This study looks into the relationship between familiarity of text, learners' preferences and comprehension performance and draws upon the principles of the abovementioned theories to answer questions related to this relationship. Essentially, it is proposed that due to the presence of the appropriate schemata (formal or content or both), the cognitive load facing a reader will be decreased, hence, resulting in ease of comprehension and memory retention (as illustrated in Figure 1).
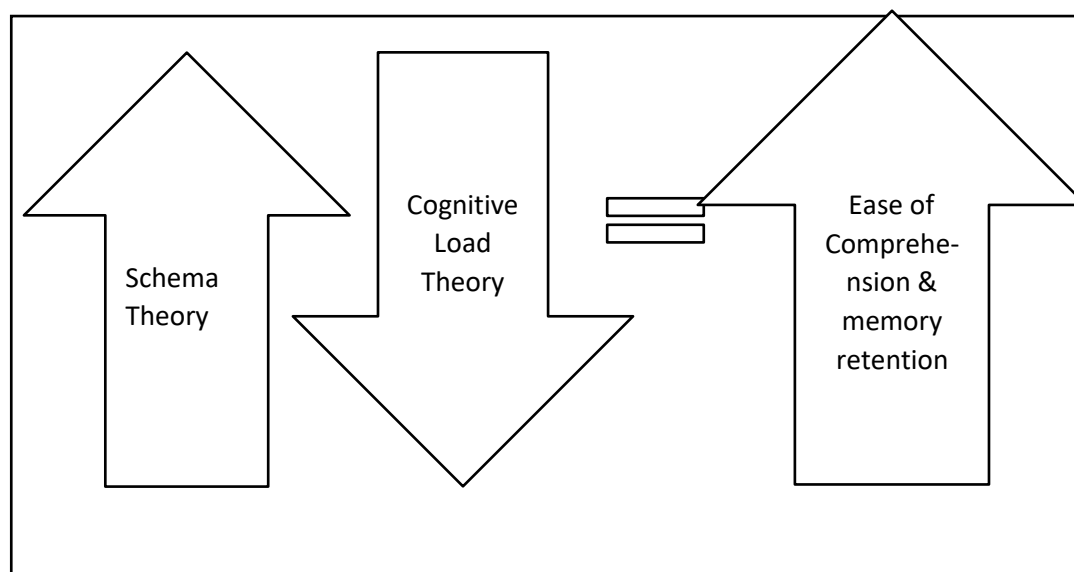
Figure 1. *Conceptual Framework of the Study*

Related Literature

In this section literature on the two key components of the research study will be presented: (1) the effects of text elements on reading and cognitive processes of readers and (2) the role of eye- tracking in investigating learners' cognitive processes in reading.

Effects of Textual Elements on Reading and Cognitive Processes

The "title" is generally acknowledged as the first linguistic information found in a text as it explains the major subject or theme of the text and functions as an indicator of points relevant to the text as well as provides a context for the interpretation of the following text (Lorch, 1989). However, it does not convey any information about how the text is organized.

Bransford and Johnson (1972), Dooling and Lachman (1971) and Dooling and Mullet (1973) had carried out research on how titles of brief texts could affect memory. In each study, the participants received either texts that lacked the title or texts with a thematic title presented at the beginning. In all the abovementioned studies, the participants had better free recall when a title was given before the text, compared to when the title came after the text or no title was given suggesting that the presence of a title had guided the participants' text processing by signposting relevant background knowledge related to information within the text. Hartley and Trueman (1985) in a series of experiments on 12 to 14 years old children, on the functions of different types of headings (for example -- questions versus statements) and on how they were positioned (marginal versus embedded) arrived at the conclusion that headings significantly helped with search, recall and retrieval.

There are other ways to aid comprehension, for example, it is found that it is easier to pick out the main ideas if the authors insert substantiating information such as examples, anecdotes and bibliographies (Hartley, 2004). Lorch (1989) further explained that typographical cues such as underlining, boldface, italics, capitalization, color variation, and

differences in spatial location help to distinguish key information from the body of text. Glynn and DiVesta (1979), Hershberger and Terry (1965) and Kulhavy (1972) found that typographical cues have the ability to improve memory of the signaled content without affecting or inhibiting unsignaled content.

In addition to that, there are indicators with pointer words or phrases that the author may use to direct readers' attention to important content that are located within the text. For example, a writer may want to emphasize on certain points by preceding it using a certain phrase such as, "It is important to note that…" Additionally, the author may want to clearly indicate the function of a statement by using phrases such as "In summary'' or "Let me conclude by…" Lorch and Lorch (1986) discovered that the presence of summary indicators can result in readers reading the signaled content more slowly, thus enabling them to pay more attention to the sentence that follows, and as a result they remember better. Hartley refers to these phrases as signals whereas Meyer et. al. (1989) describes these phrases as non-content words that function to highlight the organization of a passage. Some examples of words and phrases to indicate comparison are, *however, but,* or *on the other hand*. To provide arguments examples of words and phrases that are commonly used are *first, second, three reasons for this are*, and *a better example, however, might be . . .* These phrases Hartley (2004) states, signal the way an argument is organised (and comparisons that come with subsections). Similarly words and phrases such as *therefore, as a result, so that, in order to,* and *because* show fundamental relationships.

The Eye -tracking Research

The English Oxford Living Dictionaries (2017) defines eye tracking as a technology that observes eye movements to identify abnormalities or to research on how individuals interact with real-life texts or virtual documents. Lohmeyer and Meboldt (2015) elucidate eye tracking as a method to measure biometric characteristic -- the visual attention of participants that enables conclusions to be drawn based on the movements of their eyes.

Tobiipro (2017) (one of the companies that manufactures eye tracker devices) offers a practical description of eye-tracker. It defines eye tracking apparatus as a sophisticated device that is attached to a screen or combined with a pair of glasses that has the ability to track and record individuals' observation activity and gaze. Tobii (2017) further explains that an eye tracker would consists of cameras, projectors and algorithms. The projectors will first create a pattern of near infrared light on eyes of a user. Next, while looking at the user's image of interest, the cameras will take high-frame-rate images of both user's eyes and the movement patterns. The image processing algorithms will then find specific information in the user's eyes and reflections patterns. Finally, making use of the collected information, mathematical algorithms will then calculate the user's eyes' position and gaze points on the image of interest. There are many types of eye movements investigated. First is the "saccade" which referred to what was being looked at and processed in an image or text. Williams (2013) defines it as a particular eye movements that has a particular characteristic movement pattern. When a person is making a saccade, regardless of what an individual is attending to, the eyes will rotate with an outstanding rapidness until the eye fixates on a new point of interest and stops for some time. Most saccades will be completed under 50 milliseconds (ibid.).

Rayner (2009, 1998) define a "fixation" as a relatively stable state of eye movement which commonly ranges from 100-500 millisecond and can last up to 250 millisecond when

a person is reading. Williams (2013) states although most words are fixated at least once, some words, particularly ones that are shorter and more common, are left out entirely. It has been reported that, during a reading activity, 85% of the time content words are fixated, in comparison to function words, which receive fixations only 35% of the time (Carpenter & Just 1983). He elucidates this is to be expected because function words are among the most common words in language and tend to be the shortest. Rayner and Inhoff (1986) further discovered that words and phrases that were met often were also more likely to be processed parafoveally (and therefore skipped) than those that were met less often. Foster, Ardoin & Binder (2013) added that readers spent more time concentrating on difficult, important and long words and were most likely to skip shorter ones.

A particularly important term which will be used extensively in the current study is TCT (Total Contact Time) which refers to 'time spent'. Time spent measures the amount of time subjects of an eye tracking study have spent in an ROI (Region of Interest) (iMotions 2015). Time spent commonly represents motivation and top-down attention, since participants are thought to have disregarded other stimuli found in their visual periphery that could be equally interesting (ibid). For example, long incidences obviously show there is high level of interest towards a certain region, while short incidences show that other regions on screen or in the environment might be more interesting.

Methodology

Participants

This investigation was carried out on 33 undergraduates from a public university of Malaysia. They were Social Sciences students from two different disciplines. Seventeen were from the English Language Studies department while 16 were from the Psychology department as shown in Table 1.

To best represent the majority of Malaysian undergraduates (Malays), participants whose mother tongue was Malay were chosen. 22 (66.7%) of the participants was in their second year. The rest (33.3%) was third year students (33.3%) as shown in Table 1. First year students were not recruited as it was decided that their exposure to their major discipline was too limited in comparison to students in the second and third years and this could have an influence on their comprehension performance.

Table 1
Students Who Took Part in the Research Study

Course	English Language Studies (ELS)	Psychology	Total	Percentage (5%)
Male	2	1	3	9.1
Female	15	15	30	90.9
Number of participants	17	16	33	100

Instruments

Eye tracker device

The eye tracker device used in this study was the EyeNTNU-120 developed by the National Taiwan Normal University. The machine records eye movements of participants while the reading process is taking place, providing information regarding the reading patterns of the participants and this information is fed into a predesigned statistical package using mathematical algorithms to calculate user's eyes' position and gaze points on the image of interest.

Passages

The two passages chosen for this study can be classified as follows:

The first passage (Passage A) entitled 'Problems in Learning Spoken Language' (taken from How the Special Needs Brain Learns by Sousa, 2001) can be classified as a description type of text. It fits the criterion of a descriptive text as explained by Meyer and Freedle (1984); that it is a text that comprises a type of grouping by relationship; one type of grouping is subordinate to another (the topic). The explanation provides details about a topic by presenting features, particulars or backgrounds.

The second passage (Passage B) entitled 'Formal and Natural Concepts' (is taken from Psychology: Concepts and Applications by Nevid, 2012) can be classified as a comparison type of text. According to Meyer and Freedle (1984), comparison type of texts arranges its contents according to their similarities and differences. The points discussed in the passage are grouped together according to their similarities and differences.

The two passages comprise Social Sciences materials with Passage A, more inclined towards language learning and Passage B, more inclined towards psychology. It was predicted that the ELS students would find Passage A more familiar and Psychology students would find Passage B more familiar. Prior to the final selection the readability of the two texts were calculated using Flesh-Kincaid readability formula to ensure that both passages were around the same level of difficulty. Their readability levels are given in Table 2. This level is classified as "fairly difficult" under Flesch-Kincard's readability level and considered as appropriate for beginning college students.

Table 2
Readability levels of the Passages

Label	Title	Number of Words	Readability Level
Passage A	Problems in Learning Spoken Laguage	372	Flesch-Kincaid Grade Level**:** 11.5 Grade level: Twelfth Grade
Passage B	Formal and Natural Concepts	360	Flesch-Kincaid Grade Level: 11.9 Grade level: Twelfth Grade.

For the current study, both texts were displayed on a computer screen, with black prints on a white background and was formatted in standard upper- and lowercase letters and 20-point Times New Roman font. The reading passage was displayed as on a one-page 1.5-spaced text.

For analysis purposes, fifteen and twelve regions of interests (ROIs) were identified from Passage A and Passage B respectively. The purpose of the eye tracker was to detect whether a reader focused on these ROIs and the length of time they spent on them. See Figure 2 for the identified ROIs of passage A and Figure 3 for the identified ROIs of passage B. Table 3 and Table 4 provide the classification of the ROIs of each passage respectively.

Figure 2. *Selected ROIs of Passage A*

Table 3
Classification of Each ROI of Passage A

Region of interest (ROI)	Details	Purpose of feature
1	Typographical features	Title of passage
2	Typographical features	Heading to introduce to readers the content of the passage
3	Typographical features	Heading to introduce to readers the content of the paragraph
4	Typographical features	Heading to introduce to readers the content of the paragraph
5	Typographical features	Heading to introduce to readers the content of the paragraph and question 7

6	Structural features	The phrase indicates starting of the first main point
7	Structural features	The phrase indicates contradicting points
8	Structural features	The phrase indicate the presence of elaboration and introduce the readers to another point
9	Structural features	The phrase indicate presence of additional information to the third main point
10	Main point 1	Question 4 (implicit question)
11	Main point 2	Question 1 (explicit question)
12	Main point 2	Question 1 (explicit question)
13	Main point 2	Question 1 (explicit question)
14	Main point 3	Question 2 (explicit question) and question 5 (implicit question)
15	Main point 4	Question 3 (explicit question)

Table 4
Classification of Each ROI of Passage B

Region of interest (ROI)	Details	Purpose of feature
1	Typographical features	Title of the passage
2	Typographical features / Main point 3	Question 1 (explicit question). Main point set apart from the entire passage
3	Typographical features/ Main point 4	Question 5 and Question 6 (implicit questions). Main point set apart from the entire passage
4	Structural features	The phrase is a marker to indicate the sentence is an example
5	Structural features	The phrase is a marker to indicate the sentence is an example
6	Structural features	The phrase is a marker to indicate the sentence is an example
7	Structural features	To show contradicting points
8	Main point 1	Introduces the contents of the passage
9	Main point 2	Question 1 (explicit question)
10	Main point 3	Question 5 and Question 6 (implicit questions)
11	Main point 4	Question 2 (explicit question) and Question 4 (implicit question)
12	Main point 5	Question 3 (explicit) and Question 8 (implicit)

Interview questions

A set of interview questions was developed to find out the participants' text preferences. This was used to support the data derived from the eye-tracker. The interview questions comprised three questions asking the students for their text preferences, their perceptions of their performance for each set of question and their experiences (such as problems and challenges) while participating in the research.

Reading comprehension test

The test was undertaken as a measure of the extent of the participants' comprehension of the two reading passages. Each passage comprised of two types of questions: explicit and implicit questions. Explicit question can be defined as questions whose answers can be found directly in the text. Implicit questions are questions that require the readers to make inferences based on information in the text – to fill the gaps in the text that the author doesn't explicitly state (Johnson & Pearson, 1972).

Data Collection

Eye tracking data

It was beyond the scope of this study to utilise all the data collected. The eye-tracking data used for analysis was total contact time (TCT) (quantitative). This measure was used to measure the participants' attention span (in milliseconds) on different types of elements on the passages. This measure was used to discover the amount of time (if any) the participants had spent on the selected elements of the passages. The term 'time spent' would be used with TCT in this research. Time spent measures the amount of time subjects have spent in an ROI (iMotions 2017). The assumption adopted which is generally acknowledged in all eye-tracking research is that the more interested a person is in a particular ROI the more time he/she will be spent on that particular ROI and vice versa.

Interview responses

The interview responses (qualitative) were to elicit deeper understanding of participants' comprehension scores (quantitative) and their reading patterns (quantitative).

Comprehension test performance scores

Comprehension test scores obtained was used as a reflection of the participants' comprehension performance. The premise assumed was that the higher the scores they obtained the better they comprehended the contents of the passages.

Findings

Participants' Comprehension Test Scores

The scores obtained by the participants were calculated and recorded before grades were assigned according to the public university's grading system as shown in Table 5.

Table 5
Grades Obtained by Participants in Comprehension Tests

Text	Passage A		Passage B	
Grades	Number of Participants	Percentage of Participants (%)	Number of Participants	Percentage of Participants (%)
Grade A (85-100)	2	6.1	19	57.6
Grade A- (75-84)	9	27.3	6	18.2
Grade B+ (65-74)	6	18.2	4	12.1
Grade B (60-64)	1	3.0		
Grade B- (55-59)	2	6.1		
Grade C+ (50-54)	3	9.1		
Grade C (45-49)	1	3.0		
Grade C- (40-44)	1	3.0	2	6.1
Grade D+ (35-39)	1	3.0	1	3.0
Grade D (30-34)	2	6.1	1	3.0
Grade E (0-29)	5	15.2		
Total Number of Participants	33	100.0	33	100.0

For ease of interpretation of scores, the scores obtained are classified as follows: Participants who obtained Grades A, A- and B+ would be categorised as those who "performed well". Participants who obtained B, B-, C+ and C would be categorised as those who "performed moderately" and those who scored C-, D+, D; and E would be categorised as those who "performed poorly".

As shown in Table 5, the highest percentage of participants belonged to those who "performed well" for Passage A and Passage B. However the percentage of those who "performed well" for Passage B is very much higher than Passage A (87.9% vs 51.6%). The percentage of those who "performed poorly" is higher for Passage A than Passage B (27.3 % vs 12.1%). Finally, it is seen that there is no participants who "performed moderately" for Passage B but 21.2% of participants "performed moderately" for Passage A. Since there are more participants who "performed well" for Passage B, it can be deduced that generally the participants performed better for Passage B than for Passage A.

Eye Tracking Patterns

TCT of participants of different disciplines for Passage A

Table 6 presents the patterns of TCT of typographical features (TF) for Passage A according to disciplines. The lesser time they spent on TF, indicates the more the participants did not look at them. Table 4.11 reveals that the highest percentage is of participants did not look at TF. For ELS students 65.9% of them did not look at TF. For Psychology students 70.0% of them did not look at TF. The findings further reveal that there is a higher percentage of ELS students compared to Psychology students who looked at TF from 80-1000 ms (34.1% vs

30%). The findings clearly indicate that in general students from both disciplines did not spend much time on TF of Passage A. This pattern is slightly lower for ELS students.

Table 6
The TCT of Typographical Features (TF) for Passage A According to Disciplines

Student	ELS							Psychology						
Categories	TF							TF						
ROI	1	2	3	4	5			1	2	3	4	5		
TCT	No of students					Sum of students	%	No of students					Sum of students	%
0	14	9	14	9	10	56	65.9	15	14	13	4	10	56	70
80-250	2	7	2	6	5	22	25.9	1	1	3	7	5	17	21.2
251-500	1	1			2	4	4.7				4	1	5	6.3
501-750			1	2		3	3.5				1		1	1.25
751-1000									1				1	1.25
1001-1250														
1251-1500														
Total No. of students	17	17	17	17	17	85	100	16	16	16	16	16	80	100

Table 7 presents the patterns of TCT of Structural Features (SF) according to disciplines for Passage A. The lesser time they spent on SF, indicates the more they did not look at SF. From Table 7 it can be seen the highest percentage is of students who did not look at SF. For ELS students, 88.2% of them did not look at SF. For Psychology students 71.9% of them did not look at this feature. The findings further reveal that, there is a higher percentage of Psychology students compared to ELS students who look at SF from 80-250 ms (21.9 % vs 11.8%.). There is a remaining 6.1% of Psychology students who spent 251 ms-500 ms looking at SF. The findings clearly indicate that students spent very little time on SF of Passage A, even lesser than the amount of time they spent on TF of Passage A. However, Psychology students spent more time on SF than ELS students.

Table 7
The Patterns of TCT of Structural Features (SF) According to Disciplines for Passage A

Student	ELS						Psychology					
Categories	TF						TF					
ROI	1	2	3	4			1	2	3	4		
TCT	No of students				Sum of students	%	No of students				Sum of students	%
0	14	16	14	16	60	88.2	13	8	12	13	46	71.9
80-250	3	1	3	1	8	11.8	3	5	3	3	14	21.9
251-500								3	1		4	6.2
501-750												
751-1000												
1001-1250												
1251-1500												
Total No. of students	17	17	17	17	68	100	16	16	16	16	64	100

Table 8 presents the patterns of TCT of Main Points (MP) for Passage A according to disciplines. The lesser time they spent on MP, indicates the more they did not look at MP. Table 4. 13 reveals that the highest percentage is of students who did not look at MP. For ELS students 58.8% of them did not look at MP. For Psychology students half of them 50.0% did not look at MP. The findings further reveal that there is a higher percentage of Psychology students compared to ELS students who look at MP from 80-1000 ms (47.9% vs 41.2%) There is a remaining 2% of Psychology students who looked at MP for 1001-1500 ms. The findings clearly indicate the highest percentage is of students who did not look at MP for both disciplines. However, Psychology students spent more time on MP compared to ELS students. In general, the findings reveal that students from both disciplines spent more time on MP than TF and SC for Passage A. Finally, it can also be concluded that the pattern reveals that ELS students spent more time on TF than Psychology students. Conversely, Psychology students spent more time on SF and MP than ELS students.

Table 8

Patterns of TCT of Main Points (MP) According to Disciplines for Passage A

Student	ELS								Psychology							
Categories	TF								TF							
ROI	1	2	3	4	5	6			1	2	3	4	5	6		
TCT	No of students						Sum of students	%	No of students						Sum of students	%
0	5	10	12	13	8	12	60	58.8	2	11	6	13	6	10	48	50.0
80-250	4	5	4	4	4	4	25	24.5	6	4	7	3	6	5	31	32.3
251-500	5	2			2		9	8.8	4	1	3		3	1	12	12.5
501-750	2		1		3	1	7	6.9	1						1	1.0
751-1000	1						1	1.0	1			1			2	2.1
1001-1250																
1251-1500																
Total No. of students	17	17	17	17		17	102	100	16	16	16	16	16	16	96	100

Comparing TCT of students of different disciplines for Passage B

Table 9 presents students' patterns on the amount of time they spent on typographical features (TF) of Passage B. The lesser time they spent on TF, the more they did not look at TF. Table 9 reveals half of Psychology students did not look at TF. Meanwhile a slightly lower percentage is recorded for ELS students (41.2%). Table 9 further reveals there are more ELS students who look at TF for 80-1000 ms than Psychology students (49.0% vs 39.7%). For both groups of students there are smaller percentages of students who looked at TF for 1001 to 2500 ms with ELS having a lower percentage compared to Psychology students (9.9% vs 10.5%). The findings indicate that there is at least about 40% of students from each disciplines that did not look at TF. However, a comparison across disciplines reveal that ELS students spent more time on TF than Psychology students for Passage B.

Table 9
Patterns of TCT of Typographical Features (TF) According to Disciplines for Passage B

Student	ELS					Psychology				
Categories	TF					TF				
ROI	1	2	3			1	2	3		
TCT	No of students			Sum of students	%	No of students			Sum of students	%
0	14	2	5	21	41.2	14	2	8	24	50.0
80-250	3	4	5	12	23.5	1	4	3	8	16.7
251-500		4	3	7	13.7	1	4	2	7	14.6
501-750		3	2	5	9.8		2	1	3	6.3
751-1000			1	1	2.0	1			1	2.1
1001-1250		1	1	2	3.9		2	1	3	6.3
1251-1500							1		1	2.1
1501-1750		1		1	2.0					
1751-2000		1		1	2.0	1			1	2.1
2001-2250										
2251-2500		1		1	2.0					
Total No. of students	17	17	17	51	100	16	16	16	48	100

Table 10 presents students' patterns on the amount of time they spent on structural features (SF) of Passage B. The lesser time they spent on SF, the more they did not look at SF. Table 11 reveals that the highest percentage is of students who did not look at SF. For ELS students 86.8% of them did not look at SF. For Psychology students 76.6% of them are did the same thing. The findings further reveal that there is a higher percentage of Psychology students compared to ELS students who looked at SF for 80-500 ms (23.4% vs 13.3%). The findings clearly indicate that students spent very little time on SF of Passage B. However, in general Psychology students, spent more time on SF than ELS students for Passage B.

Table 10
Patterns of TCT of Structural Features (SF) According to Disciplines for Passage B

Student	ELS						Psychology					
Categories	TF						TF					
ROI	1	2	3	4			1	2	3	4		
TCT	No of students				Sum of students	%	No of students				Sum of students	%
0	16	12	15	16	59	86.8	11	11	12	15	49	76.6
80-250	1	5	1	1	8	11.8	5	4	3	1	13	20.3
251-500			1		1	1.5		1	1		2	3.1
501-750												
751-1000												
1001-1250												
1251-1500												
Total No. of students	17	17	17	17	68	100	16	16	16	16	64	100

Table 11 presents students' patterns on the amount of time they spent on Main points (MP) of Passage B. The lesser time they spent on MP, the more they did not look at MP. Table 4.16 reveals there is a higher percentage of ELS students than Psychology students who did not look at MP of Passage B (47.1% vs 35.0%). The findings further reveal there are more Psychology students than ELS students who looked at MP of Passage B for 80-1000 ms, is (61.8% vs 49.4 %). There are smaller percentages of students who looked at MP for more than 1000 ms but the number is too small to be of any consequence. Comparing across disciplines, it is revealed that Psychology students spent more time on MP than ELS students.

Table 11
Patterns of TCT of Main Points (MP) According to Disciplines for Passage B

Student	ELS							Psychology						
Categories	TF							TF						
ROI	1	2	3	4	5			1	2	3	4	5		
TCT	No of students					Sum of students	%	No of students					Sum of students	%
0	6	9	11	7	7	40	47.1	4	6	4	3	11	28	35.0
80-250	3	4	2	4	8	21	24.7	3	4	8	8	2	25	31.3
251-500	4	3	2	3	1	13	15.3	2	3	3	2	2	12	15.0
501-750	2	1	1	2	1	7	8.2	5	2	1	2		10	13.0
751-1000			1			1	1.2				1	1	2	2.5
1001-1250								2					2	2.5
1251-1500	1					1	1.2							
1501-1750														
1751-2000	1					1	1.2							
2001-2250			1				1.2							
Total No. of students	17	17	17	17	17	85	100	16	16	16	16	16	80	100

In conclusion, it is possible to surmise that similar to Passage A, students from both disciplines spent more time on MP than TF and SF for Passage B. A comparison across disciplines for the three types of features also reveals another pattern similar to Passage A that is ELS student spent more time on TF than Psychology students. Conversely, Psychology students spent more time on SF and MP that ELS students.

Students' Opinions of Passages

Passage preference

After having read the passages and answered the comprehension questions, the students were asked a few questions in an interview session. The first question was on which passage they find easier to understand.

Table 12
Overall Passage Preference of Students

Passage	Preference	Percentage (%)
A	1	3.0
B	28	84.8
Unknown	4	12.1
Total	**33**	**100**

Table 12 presents the overall passage preference of the students. As shown majority of the students (84.8%) indicates preference for Passage B. Only 3.0% shows preferences for passage A. It was not possible to contact four students hence their preference was classified as "unknown".

Reasons for passage preference

It was possible to identify eight different reasons for passage preference from an analysis of the interview data. The categories are: (1) terms used (2) familiarity of content (3) organisation of contents (4) participants' focus,(5) the influence of first passage, (6) number of points (7) physical organisation and (8) other reasons. Figure 4 displayed the percentages of the various reasons given for their preference.
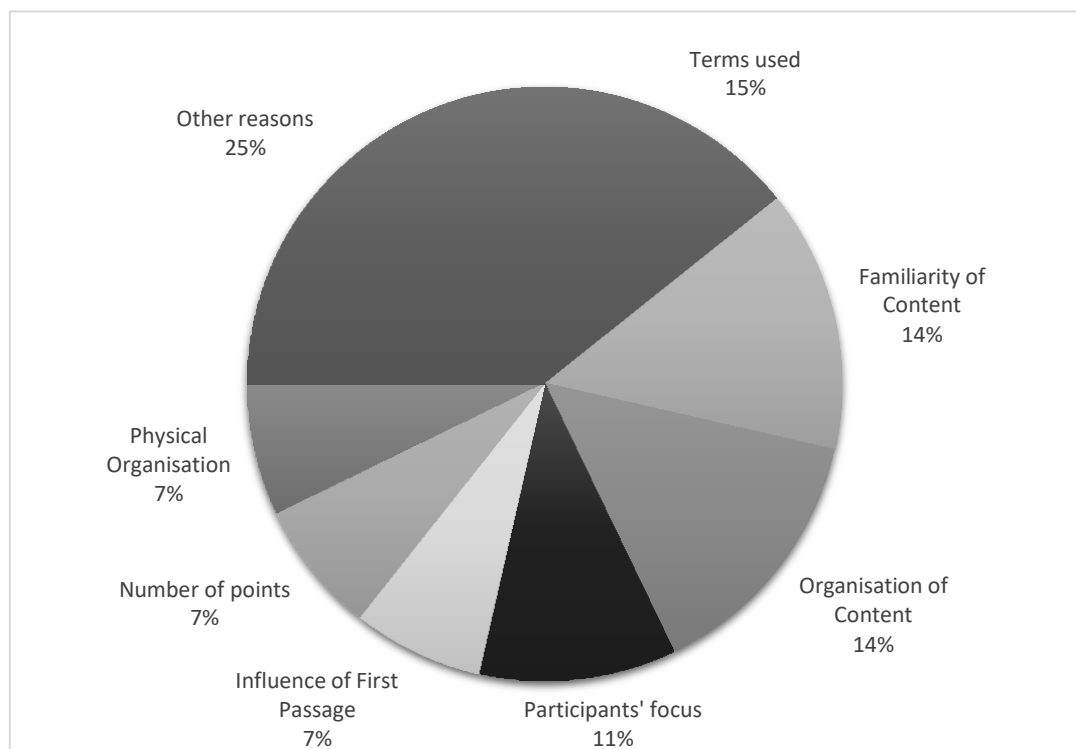

Figure 4. *Pie Chart Showing Percentages of Students' Reasons for Passage Preference*

According to RAND (2002) factors that influence reading comprehension can be classified as readers, text and the activity in which reading is taking place. Using Rand's

classification it is possible to divide the reasons given in this study into types: text-based reasons and reader-based reasons. Text-based reasons which are influenced by formal schemata include terms used (15%), organisation of content (14%), number of points (7%) and physical organisation (7%). Total percentage under this category is 43%. On the other hand, reader-based reasons which are influenced by the content schemata include familiarity of content (14%), participants' focus (11%) and influence of first passage (7%). Total percentage under this category is 32%. Thus it can be seen here that text-based reasons has a greater influence on passage preference than reader-based reasons. Table 14 gives some examples of the reasons given by the students according to category.

Table 13
Some Examples of the Reasons Given by the Students According to Category

Category	Examples of reasons given	Classification of reasons
Text-based reasons	Second one, because the topic includes more direct terminologies and easy to be understand even after skimming and a full reading process. (E10)	Terms used
	I think the second one is easier because the first one has too many terms in it which does not interest me too much so that's why I couldn't remember anything about it. (E15)	
	The second passage. Second passage because the words used in the passage are of much easier to understand (E17)	
	Passage 2 because the words they use in passages 2 simple and can understand what they are trying to say. (P13)	
	Because reader (me) can read the text faster as it is not too congested with information and it is written in a systematic way.(E16)	Organisation of content
	It is organised compared to the first one that I had to reread to understand and find points. (P5)	
	I think that the second passage is more understandable from the first one. The structure of the text for the second one is more well organised. (E3)	
	It consists of two different points that can be compared easily whereas the first text had 3 points to compare to. (E8)	Number of points
	Second passage...because its passage only have two subtopic I have to think and the word on that passage more easier to understand (P16)	

	Passages two is much easier to be understand as the position of the passage side-by-side makes it looks quite shorter compared to the first passage (E11)	Physical organisation
	Second passage because it more easy to read and the space gap is big and look more simple (P14)	
Reader-based reasons	Because the passages is all about psychology things. It easier for me to remember because I can relate on my daily basis (P2 student).	Familiarity of content
	Second because less technical terms and more relatable to everyday life. (E5)	
	E12:The second one because the second one is easier to read and remember compared to the first one	
	E12: It is because the passage is clearer in terms of sentence lengths and words used. It also because of the topic discussed in the passage is familiar and easy to comprehend (E12)	
	The second passage. I thought that it is easier because it is more related to myself. (P10)	
	The second one. Maybe because it is easier for me to understand since I read it slower and more focus. (P3)	Participant's focus
	Soalan kedua sebab saya lebih fokus sewaktu membaca petikan tersebut.	
	(Second question because I was more focused reading the passage) (P12)	
	Passage 2. Sebab lebih fokus masa yang kedua.	
	(I was more focused reading second passage) (P6)	
	Second because I was more aware of what I was supposed to do based on the first set (passage A) which is read repeatedly. (E7)	Influence of first passage
	Second. Because I have been adapted from the first one. Much more relax to read the passage. (P7)	

Key: P= psychology student; E= ELS student

Discussion

For this section the findings of the study are discussed in line with the research questions

Research Question One

Do the participants' passage preferences match their comprehension performance?

The interview findings reveal that majority of the participants from both disciplines prefer Passage B and their comprehension scores is also higher for Passage B than A. The findings clearly show the participants' passage preferences do match their comprehension performance.

Research Question Two (a):

What do the eye tracking data reveal regarding reading patterns of ELS and Psychology students when reading (i) Typographical Features (TF), (ii) Structural Features (SF) and (iii) Main Points (MP) of Passage A and B?

The eye tracking data reveal that students in general do not spend much time on TF regardless of the discipline they are from. Both groups spend even less time on SF. However, both groups spend more time on MP but the amount of time spent is still very low as about 40% of them do not look at MP. A comparison across disciplines reveal that in general ELS students pay more attention to TF than Psychology students. Conversely, Psychology students pay more attention to SF and MP than ELS students. However, there is no difference between the two passages with regard to the abovementioned patterns which suggests that the types of passages (i.e. descriptive versus comparison) do not have much influence on students' reading processes.

As mentioned earlier, the findings suggest that students are more aware of the importance of looking at the MP than other features. Most probably they had been taught by their teachers to look at long sentences to get important information. This is in line with Foster, Ardoin and Binder (2013) who state that previous eye movement research studies reveal that readers spend more time concentrating on difficult, important and long words and are most likely to skip shorter ones. However it is still very disturbing that about 40% of them do not look at MP which makes one wonders how the students managed to answer the comprehension questions correctly. There is also a possibility that some students skimmed through them and these movements were not recorded by the eye-tracker.

A higher percentage of students pay more attention to TF than SF which means they are more aware of TF than SF. This is not too surprising as TF are usually differentiated from the text by their location and typeface. Some examples provided by Lorch (1989) are, titles and headings that are presented differently (such as they are underlined, capitalized or there is a difference in spatial location) from the text.

SF is the least recognised. This could be because SF in the two passages are short, functional (instead of content) and common words and phrases, (such as it describes, even though, when, sometimes and but) therefore the participants may have skipped them when reading. Hartley (2004) who cited Meyer et al. (1989) defined them as non-content words or phrases that are used to help readers recognise the way a passage is organised. However, the fact that they have scored reasonably well in the comprehension tests of both passages suggests that ignoring these features have not badly affected their comprehension of the passages. There is a possibility that they looked at them so briefly that the eye-tracker failed to record these activities. Rayner and Inhoff's findings (1986) support this. They found that

words and phrases that are met often are also more likely to be processed parafoveally (and therefore skipped) than less often ones.

Lack of attention towards TF and SF in comparison to MP, could be due the students are not taught to emphasize on other features than MP. This is in line with Noorizah (2006) findings, in which she stated, students constantly use a variety of strategies to pick out keywords or main points in the text but tend to ignore other features of the text.

Research Question Two (b)

What is the relationship between reading patterns and reading comprehension scores of Passage A and B?

There is no clear-cut relationship between reading patterns and reading scores. Generally, students from both disciplines perform better in Passage B than Passage A. However, the reading patterns for both Passages are the same that is they spend more time on MP followed by TF and SF for both passages. However, there is some indication that students in general spend more time on TF and MP for passage B than Passage A which suggests that this may have helped them to do better for Passage B.

Research Question Three

What do the findings tell us regarding the participants' reading processes and reading preferences?

The findings clearly indicate that reading preferences is a very important determinant of students' performance. The way they process the passages may not be very different, resulting in a lack of significant differences in the reading processing of both passages but the fact that they prefer Passage B more than Passage A for a variety of reasons enable them performed very much better for Passage B. This conclusion is derived from their responses during the interviews. The findings indicate that text-based reasons has a greater influence on passage preference than reader-based reasons. Thus, it would appear that formal schemata which include rhetoric structure of the text is more important in determining reading performance than content schemata which include readers' experience, familiarity with content and background knowledge. Aligning this with the conceptual framework, it can be surmised that texts with more organised and clearer rhetoric structures will reduce readers' cognitive load and hence enabling ease of comprehension and better memory retention. Simmonds and Reynolds (1989) further stress that readability and legibility are the key factors to 'ideal' text for readers. Ong (2011) in her study found evidence to further support this. She discovered that students were more interested to read when given a newer version of a textbook which had more images and colour compared to an older version of the of textbook that lacked these features. Thus it is evident here that the presentation of a text does influence readers' interests consequently leading to lower cognitive load and better comprehension.

Reader-based reasons which are influenced by readers' preference, experience and background knowledge seemed to be less crucial in determining preference and comprehension performance. However it has to be pointed out here that one of the reasons that students did better for Passage B was that they had been exposed to Passage A first.

Student E7 said " *Second because I was more aware of what I was supposed to do based on the first set which is read repeatedly.* Thus, in future research maybe it is better to give half of the students Passage A first and the other Passage B first.

Implication of the Findings and Conclusion

This study had its focused on exploring the effects of university students' reading processes and preferences on comprehension of two different types of passages. There were two types of texts used (description and comparison) and these were tested on two groups of participants (ELS and Psychology participants). Results obtained show the students of both disciplines prefer Passage B than A. It was further discovered that formal schemata was more influential in determining preference and comprehension performance than content schemata. Hence it is recommended that academics and publishers seriously consider the organization and rhetoric structures of texts when designing materials for students of various levels moving from less complex to more complex structures and organization and also supporting students in other ways like providing guide books and instructional guides. Texts chosen should be systematically organized enabling students to identify, draw and process relevant information without confusing them unnecessarily and as a result causing them to lose interest in reading the recommended texts. Physical organisation of texts also plays a part in readers' preferences and comprehension process. Thus texts chosen should be visually appealing and attract attention. Providing more relatable and culturally familiar materials should also be considered to further aid comprehension and to compensate when dealing with difficult texts.

The findings clearly indicate that the students lack reading strategies as they did not give sufficient attention to MP, TF and SF of the two passages. Thus it is essential that such strategies be taught. It is proposed that these strategies be taught at lower levels and reinforced at high levels.

The study has yielded some very illuminating findings, despite that, there are some limitations that need to be considered in future studies. First, the sample size is rather small for a research involving the use of an eye tracker. It is recommended that for future research a larger sample population (at least double the current number for each cohort) be used. This would allow the emergent of a more comprehensive set of patterns. The sample population comprised of only Malay students from two disciplines. A comparative study involving students from diverse disciplines and ethnic origins and possibly from different institutions of higher learning will yield richer data and enable clearer understanding of the reading patterns of Malaysian students as a whole. As it is the findings are not generalizable and it is not possible to use inferential statistics to increase the reliability of the types. Finally, the types of texts used should also be increased to allow a more in-depth analysis of the effects of the various features of different types of texts on reading patterns, preference and comprehension performance.

References

Bransford, J. D., Johnson & M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behaviour*, 11(6), 717-726.

Carpenter, P. A. & Just, M. A. (1983). What your eyes do while your mind is reading. In K. Rayner (eds.). *Eye Movements in Reading: Perceptual And Language Processes*, 275-307. Cambridge, UK: Academic Press.

Carrell, P. L & Eisterhold, J. C. (1983). Schema Theory and ESL reading pedagogy. *TESOL Quarterly* 1(4), 533-573.

Deia Ganayim & Raphiq Ibrahim. (2013). How do typographical factors affect reading text and comprehension performance in Arabic? *The Journal of the Human Factors and Ergonomics Society,* 55(2), 323-32.

Dooling, D. J. & Lachman, R. (1971). Effects of comprehension on retention of prose. *Journal of Experimental Psychology,* 88(2), 216-222.

Dooling, D. J., & Mullet, R. L. (1973). Locus of thematic effects in retention of prose. *Journal of Experimental Psychology,* 97(3), 404-406.

English Oxford Living Dictionaries. (2017). Ideal. Retrieved from https://en.oxford dictionaries.com/definition/ideal

Fielden, K. (2004). Evaluating Critical Reflection for Postgraduate Students in computing. *Informing Science and Information Technology Education Joint Conference, 2005*, Flagstaff, Arizona, United States of America.

Foster T., Ardoin S. & Binder K. (2013). Underlying changes in repeated reading: An eye movement study. *School Psychology Review,* 42(2), 140-156.

Glynn, S. M. & di Vesta, F. J. (1979). Control of prose processing via instructional and typographical cues. *Journal of Educational Psychology*, 71(5), 595-603.

Hartley, J. & Trueman, M. (1985). A research strategy for text designers: The role of headings. *Instructional Science*, 14(2), 99-155.

Hartley, J. (2004). Designing instructional and informational text. In Hartley, J. *Designing Instructional Text.* In D, Jonassen (ed.), *Handbook of Research on Educational Communications and Technology*. pp. 917-947. Mahwah, New Jersey: Lawrence Erlbaum.

Hershberger, W. A. & Terry, D. F. (1965). Typographical cuing in conventional and programmed texts. *Journal of Applied Psychology* 49(1), 55-60.

iMotions. (2015). 7 Most used eye tracking metrics and terms. Retrieved from https://imotions.com/blog/7-terms-metrics-eye-tracking/

Kulhavy, R.W. (1972). Effects of embedding orienting stimuli in a prose passage. *Psychonomic Science*, 28(4), 213–214.

Lohmeyer, Q & Miboldt. (2016). The integration of quantitative biometric Measures and Experimental Design Research. In Cash, P., Stankovic, T. & Storga, M. (eds.). *Experimental Design Research,* pp. 97-112. Switzerland: Springer.

Lorch, R. F. (1989). Text-signaling devices and their effects on reading and memory processes. *Educational Psychology Review,* 1(3), 209-234.

Lorch, R.F. & Lorch E. P. (1986). On-line processing of summary and importance signals in reading. *Discourse Processes,* 9(4), 489-496.

Meyer, B. J. F, & Freedle, R. O. (1984). Effects of discourse type on recall. American *Educational Research Journal*, 21(1), 121-143.

Meyer, B. J. F., Young, C. J., & Bartlett, B. J. (1989). *Memory improved: Reading and memory enhancement across the life-span through strategic text structures*. Hillsdale, NJ: Erlbaum.

Nevid, J. S. (2012). *Psychology: Concepts and Applications 4th Edition*. Belmont, California: Wadsworth Cengage Learning.

Noorizah Mohd. Noor. (2006). Reading academic text: awareness and experiences among University ESL learners. *GEMA: Online Journal of Language Studies,* 6(2), 65-78.

Ong, S. (2011). Aesthetics in reading: can text and images help or hinder reading? *International Journal of Arts and Science*s 4(18), 245-253.

Pearson, P. D. & Johnson, D. D. (1972). *Teaching reading comprehension.* New York: Holt, Rinehart & Winston.

Ramatu Abdulrasheed Haliru, Marjanatu Abdulkarim, Aliyu Dogara, Mohammed, Babangida Umar Dangani. (2015). An assessment of reading habit among secondary school students in Kaduna metropolis. *IOSR Journal of Humanities and Social Science,* 20(10), 12-17.

RAND Reading Study Group. (2002). *Reading for Understanding: Toward an R & D Program in Reading Comprehension*. 1 January.

Rayner, K. & Inhoff, A. W. (1986). Parafoveal word processing during fixations in reading: Effects of word frequency. *Perception & Psychophysics*, 40(6), 431-439.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin,* 124(3), 372 -422.

Rayner, K. (2009). Eye movements in reading: Models and data. *Journal of Eye Movement Research,* 2(5), 1-10.

Reynolds, L & Simmonds D. 1989. *Presentation of Data in Science 5th Ed*. The Netherlands: Martinus Nijhoff Publishers.

Sousa, D. A. (2001). *How the Special Needs Brain Learns*. Thousand Oaks, California: Corwin Press Inc.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science* 12: 257-28 Miller, G.A. 1956. The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review,* 63, 81-97.

Tobii. (2017). Humanizing your technology. Retrieved from https://www.tobii.com/tech/

Tobiipro. (2017). Envision human behavior. Retrieved from https://www.tobiipro.com.

Urquhart, A. H. (1984). The effect of rhetorical ordering on readability. In J. C. Alderson & A. H. Urquhart (eds.), *Reading in a Foreign Language*. New York, NY: Longman.Wan Hurani Osman & Anna Lynn Abu Bakar. (2009). Learning to write an academic paper among medical students of Universiti Malaysia Sabah. Paper presented at the 2nd International Conference of Teaching and Learning (ICTL 2009) INTI University College, Malaysia, November 16-18.

Williams, C.C. (2013). Eye movements and cognitive psychology: How can eye movements work as a window on mental processes? *MSU Create for STEM Eye-Tracking Conference,* Michigan State University, United States of America. Retrieved from https://create4stem.msu.edu/event/eye-tracking-mini-conference/1278

Zaira Abu Hasan. (2008). Peer interaction and meaning construction among ESL learners in comprehending texts in 2nd language context. Ph.D. Thesis, Universiti Putra Malaysia.

Zhu Y. (2005). *Written Communications across Cultures.* Amsterdam: John Benjamins
    Publishing Company.