Metacognitive Online Reading and Navigational Strategies by Science and Technology University Students

Ruhil Amal Azmuddin
ruhilamal@ump.edu.my
Universiti Malaysia Pahang

Nor Fariza Mohd Nor
fariza@ukm.edu.my
Universiti Kebangsaan Malaysia

Afendi Hamat
fendi@ukm.edu.my
Universiti Kebangsaan Malaysia

ABSTRACT

Reading has taken a new dimension, where students in higher institutions are consistently required to read massive amounts of online materials to gain knowledge, complete tasks and assignments. Hence, the ability to read online effectively is becoming increasingly important, as students need to utilize, understand and respond to online materials. However, most university undergraduates lack the ability to read effectively and critically. Therefore, the present study examines university students' metacognitive online reading strategies and navigational strategies in reading English Science and Technology hypertexts for academic purposes. Data were collected through an online survey among 55 Science and Technology students in a public university situated in the east coast of peninsular Malaysia to identify the most frequent metacognitive online reading strategies used by the students. The survey revealed that students used problem-solving strategies the most followed by global and support reading strategies. Out of the same sample, 12 students were purposively selected to be a part of qualitative data collection on navigational strategies that was conducted through individual screen recordings captured through a screen recording software. The software recorded the on-screen activities while students were using an interactive reading system named iREAD; Interactive Reading for Academic Disciplines. Based on the screen recordings, it can be observed that students mostly used mixed overview strategies followed by serial overview strategies, and serial navigational strategies when reading online materials. The findings concluded the need to teach students metacognitive awareness in order to read online materials successfully to make learning more efficient, meaningful and beneficial.

Keywords: metacognitive online reading strategies; navigational strategies; English for Specific Purposes; English for Science and Technology; higher institutions

INTRODUCTION

As the influence of internet is growing and higher institutions get connected to the internet, the use of online reading materials in teaching and learning is becoming a widespread practice. This is an indication that students at higher institutions are required to read massive amounts of online materials. They spend long hours on the internet to complete tasks, assignments and acquire knowledge. Acquiring knowledge via the internet is seen to provide educational advancements for students especially at higher institutions (Nor Fariza Mohd Nor, Hazita Azman, & Afendi Hamat, 2013). In addition, reading materials in higher

institutions are often long, difficult and unfamiliar, hence, it can be a daunting experience for many students. For example, students may struggle reading academic scientific materials which are in English if it is not their first language. Therefore, students in higher institutions need to effectively read online materials in order to comprehend and synthesize these types of texts.

The increase of time-spent reading online has led to the development of a new style of reading; from the traditional left-to-right to the non-linear way of reading. The non-linear way of reading refers to the ability to navigate to different parts of online materials without having a specific way of reading, allowing the reader to have control of the reading process (Akyel & Erçetin, 2009). This style of reading is often referred to as "hypertextual" form of reading "hypertexts" (Sung, Wu, Chen, & Chang, 2015, p. 2). Hypertexts refer to a type of text displayed on any electronic devices consisting of nodes and hyperlinks that are interconnected, where the nodes are considered as a complex web-like structure. The nodes or also known as hyperlink can be connected to an endless number of other text that can be instantly accessed online. Due to its structure, it allows the same hypertexts to be read by readers in different order and at different times (Sung et al., 2015). In contrast, the information in linear texts is structured and the nodes are connected with each other, following a specific order like a book. As a result, it is becoming increasingly difficult to ignore the fact that online reading requires certain strategies because of the complex nature of hypertexts. This is because hypertext or online reading is usually related to solving a problem as compared to offline reading that may take the form of reading for pleasure (Herold, 2014). This form of online reading is increasing at a fast pace and is often linked to the ability to navigate between hypertexts, which involves the use of metacognition awareness. According to Sheorey and Mokhtari (2001), metacognition awareness are reading strategies that students employ during reading. They further elaborate metacognitive awareness as readers' ability to set reading goals and awareness of reading process. It is a technique for learners to plan, regulate and manage their online reading (Anderson, 2003; Ramli, Darus, & Bakar, 2011; Sheorey & Mokhtari, 2001). In addition, navigational strategies reflect on the act of scrolling up and down web pages and clicking hyperlinks, which is also known as hypertext navigational strategies (Protopsaltis, 2008).

In view of this, this study aimed to identify students' metacognitive online reading strategies and navigational strategies in reading English for Science and Technology (EST) hypertexts, for academic purposes. In order to achieve these aims, this study addressed the following research questions:

1. What metacognitive online reading strategies do Science and Technology students use the most in reading hypertexts for academic purposes?
2. What navigational strategies do students use the most in reading EST hypertexts?
3. Why did EST students employ metacognitive online reading strategies and navigational strategies when they read EST hypertexts?

ONLINE READING

Online reading or hypertext reading is viewed as a complex process that requires the act of deciphering letters or words on hypertexts. According to Sung et al. (2015), online reading has shifted from the traditional form of reading newspapers, books or magazines to reading non-traditional media such as reading of different forms of information like videos, hyperlinks and sounds. The concepts or ideas are information presented in a non-linear order, allowing readers to read in any order they prefer. In general, hypertexts do not follow a specific order of reading, where readers can read in a non-linear manner transferring offline

reading strategies to online reading (Akyel & Erçetin, 2009). This implies that online reading is a unique process for it differs from reading traditional printed texts because readers are able to read not only normal electronic texts, but also materials in an online environment. However, this also means that readers need knowledge on appropriate reading strategies in order to be successful in reading online materials of various formats.

Park, Yang, and Hsieh (2014), looked at how university level students construct meaning when reading online through the use of information-seeking strategies and decision-making processes by extending the theory of cognitive flexibility (Spiro, 2004). They found that cognitive flexibility is manifested through various information gains, diversified information search and ability to use online resources. Students were able to exercise cognitive flexibility through synthesizing information from various online resources in achieving understanding of certain phrases or concepts that they came across. Students were also able to broaden their scope of information search by constructing meaning from multiple online resources and develop their own ability for computer search skills.

READING STRATEGIES

There are two major categories of reading strategies: cognitive and metacognitive strategies. Cognitive strategies refer to strategies that aid the readers in constructing meaning of the texts, whereas metacognitive strategies are strategies that control cognitive strategies (Devine, Carrell, & Eskey, 1987). According to Carrell, Devine, and Eskey (1988), cognitive strategies relate to the mental processes of the target language consisting of local and direct strategies. Local strategies are those used in bottom-up processing such as word identification, whereas direct strategies are used in top-down processing such as inferencing.

Metacognitive strategies are those employed during reading, where learners set their reading goals and are aware of their reading process (Carrell et al., 1988). It is the ability to administer, control and understand what they are reading in order to encourage critical thinking. Clearly, traditional reading and online reading are different, which implies the need to train students at higher institutions how to read online effectively (Afendi Hamat, Nor Fariza Mohd Nor, Hazita Azman, Nadzrah Abu Bakar, & Noorizah Mohd Noor, 2010).

METACOGNITIVE ONLINE READING STRATEGIES

In recent years, various studies have focused on metacognitive awareness as a reading strategy at university level. For example Vaičiūnienė and Užpalienė (2013), explored metacognitive online reading strategies employed by 89 undergraduate university students in reading academic online texts. Data was collected through Online Survey of Reading Strategies (OSORS) by identifying strategies used the most by students. The study found that problem solving strategies had the highest use with a mean score of 3.43. This implied that students adjust their reading speed, reread a difficult text and guessed the meaning of difficult words in reading online materials. Similarly, Pookcharoen (2009) found 46 out of 89 students employed problem-solving strategies the most in reading online materials. Their study concluded the need to develop metacognitive online reading strategies for students to be able to critically evaluate information on the internet. However, in a study among 54 ESL university students, contrasting results were reported. The study found that students used global reading strategies the most in reading online texts followed by problem solving and support strategies (Ostovar-Namaghi & Noghabi, 2014). This demonstrated that students had a purpose in mind when reading online texts because global reading strategies entails planning their reading, previewing the text, and predicting about the texts. Hence, makes readers become more focused and active readers.

In addition, studies on metacognitive online reading strategies have shown the benefit of the strategies as students are able to identify their reading problems, monitor their reading and adjust their learning strategies (Akyel & Erçetin, 2009; Huang, Chern, & Lin, 2009; Lan, Lo, & Hsu, 2014). It will assist them to achieve comprehension due to the fact that readers will know how to read online texts through the use of metacognitive strategies. For example, having a purpose in mind and using contextual clues in order to understand online materials. According to Anderson (2003), research into metacognitive strategies has classified these strategies as below:

1. Global strategies – where readers plan their reading by previewing the text or having a purpose in mind.
2. Problem-solving strategies – where readers use actions in order to understand a text by guessing the meaning of words or rereading it.
3. Support strategies – where readers use aids to assist in reading such as using online dictionaries or highlighting.

Based on these subcategories proposed by Anderson (2003), Online Survey of Reading Strategies (OSORS) was developed to measure students' metacognitive reading strategies in reading hypertexts for academic purposes. Anderson (2003) believes that online reading abilities of L2 readers can be promoted through the strategies outlined in OSORS.

NAVIGATIONAL STRATEGIES

Navigational strategies involve scrolling up and down web pages, clicking hyperlinks and moving the cursor in a linear or non-linear manner. Studies on navigational studies have identified three important elements: selection of links (Amadieu, Tricot, & Mariné, 2009; Madrid, Van Oostendorp, & Puerta Melguizo, 2009) overview processing strategies (Salmerón, Baccino, Cañas, Madrid, & Fajardo, 2009) and hypertext navigational strategies (Protopsaltis, 2008). However, this study focused on one form of navigational strategy identified by Protopsaltis (2008) that he coined as hypertext strategies because the researchers wanted to explore navigational patterns of readers. These strategies include *serial strategy, serial overview strategy, mixed strategy* and *mixed overview strategy*. The three strategies differ in the ways readers navigate within an online environment. *Serial* strategy refers to readers who read in a detailed way at the beginning up until the end by selecting links as soon as they see them. They read in a serial/ linear way. Similarly, *serial overview* takes on the same principle (reads in a linear way) but the contrast is whether readers would scan first before or during reading. Another strategy is *mixed* strategy, where reading involves dual way of reading either randomly and/ or sequentially. While *mixed overview* reflects readers who scan the text before or during reading but then reads in either a linear or random order. Protopsaltis (2008) found that students need to rely on both metacognitive online reading strategies and navigational strategies when reading in an online environment. However, his study found that students used serial strategy the most as they relied on familiar strategy of traditional reading when reading online materials. The study concluded that students have not developed the relevant schemata in an online environment and suggests hypertexts selection should be based on readers' interests.

THEORETICAL FRAMEWORK

This study was mainly guided by Constructivism and Connectivism Theory of learning. Constructivism is a humanistic model that suggests learning as a process that learners go

through by constructing new ideas or concepts based on their experiences and new knowledge. The learner is in control of what is learnt and depends on schema to choose and change information or knowledge, create prepositions and make decisions. Vygotsky (1980), put forward the idea zone of proximal development (ZPD), where the cognitive development is limited to a certain gap and that learning during ZPD is dependent fully on social interaction. He believes that learners achieve more with teacher guidance and peer collaboration as compared to working alone. In relating this approach to the present study, reading online is associated with social and cognitive learning process because the students were using an online platform in a collaborative environment, which reflected social and cognitive learning processes.

Besides constructivism, this study also applied connectivism theory because it emphasizes on learning across networked learning communities and technologies. Dubbed "the learning theory for the digital age" by Siemens (2004), the principles behind the theory posits that learners construct knowledge based on their learning networks by making connections between ideas, concepts, perspectives and opinions via the internet such as web search engines and electronic databases. This is because learners use various information resources and technologies in order to make connections between ideas that are located throughout their personal learning networks (Dunaway, 2011). Another rationale for applying this theory is because the theory acknowledges the importance of networked information technology as an important component in the learning process. The same principles can be found in recent technologies used by students such as MOOCs, Diigo, Wikis, YouTube and Facebook (Goldie, 2016). These digital platforms are used to make connections with content and other communities in order to construct knowledge. Similarly, the current study also applied the use of an online platform in learning.

METHODS

RESEARCH BACKGROUND

The aim of the present study was to investigate metacognitive online reading strategies and navigational strategies used by students in reading EST hypertexts for academic purposes. These objectives were achieved through the use of an online reading system, named Interactive Reading for Academic Disciplines (iREAD) (Nor Fariza Mohd Nor, Afendi Hamat, Hazita Azman, Noorizah Mohd Noor, & Vengadasamy, 2014). iREAD is an online reading platform that consists of e-tools to assist in reading and viewing various forms of academic online materials such as video and audio recordings. It is also an online platform that encourages social interactions among learners because of its functions. The functionalities in iREAD include discussion page, annotation tools, tasks page and list of questions (i.e. multiple choice and true and false question formats). Figure 1 is a screenshot of one of iREAD functions, which is the annotation tool.

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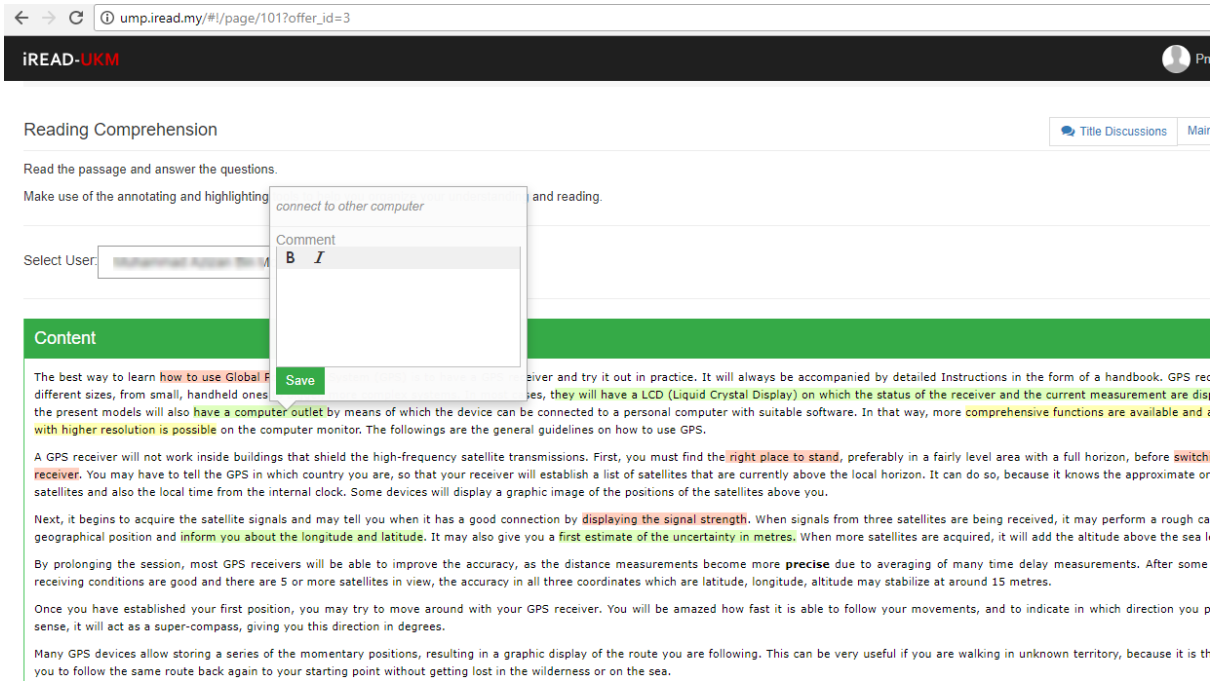

FIGURE 1. Screenshot of annotation tool functions

The annotation tool allows for markings by using highlighting functions with the use of either green, red or yellow highlighter. Another function of annotation tool is that students are able to write short notes on the highlighted points made. This tool is significant in reading as it allows learners to recall, synthesize ideas and summarize points. Moreover, learners can also view others' annotations, which makes learning more interactive.

iREAD was also developed to allow teachers to monitor students' progress when they read academic online reading materials. The tools created are intended to encourage interactive and collaborative learning. Hence, another function was the asynchronous discussion page that was designed to allow students and teachers to post questions and discuss issues related to the topic of discussion. Figure 2 is a screenshot of a discussion page that can be found in iREAD.

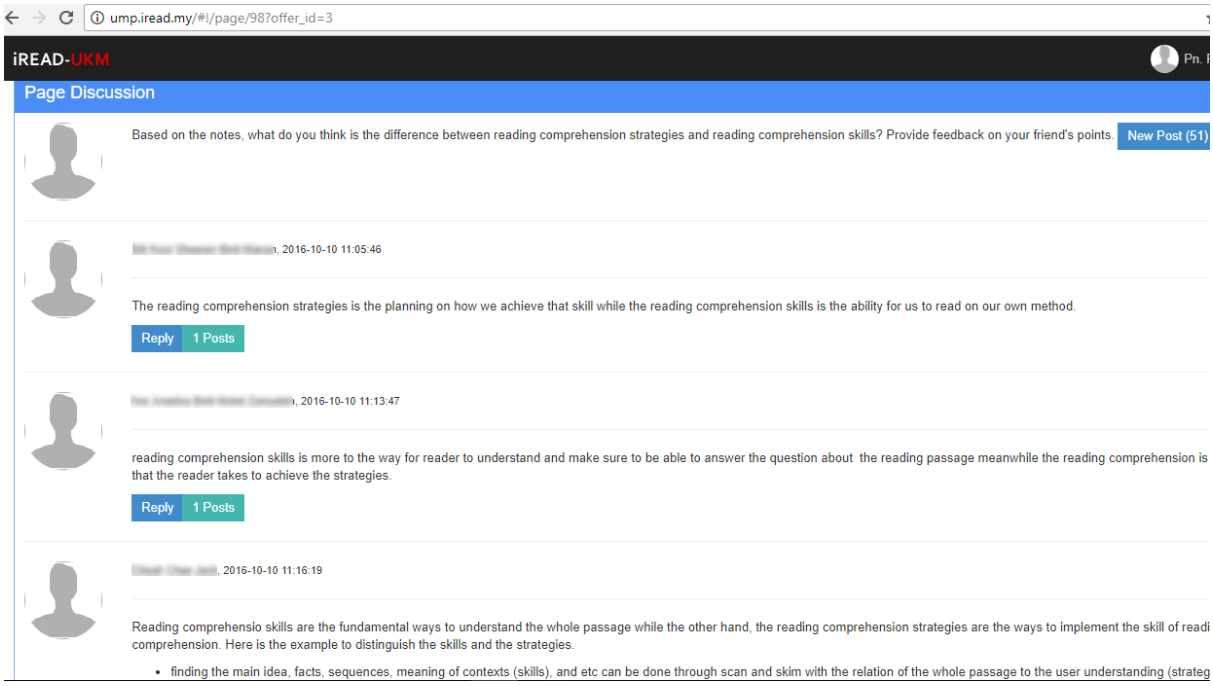

FIGURE 2. Screenshot of discussion page

This discussion page example is an activity where the students read a text and completed a comprehension activity and discuss the differences. As illustrated in figure 2, students provided their opinions and were able to read others' opinions, making it a collaborative form of learning as well. The preceding paragraphs describe the participants, the instruments and data collection procedures.

PARTICIPANTS

The participants of this study consisted of 55 students enrolled in various undergraduate Science and Technology programs in a public university in the east coast of peninsular Malaysia. The participants were selected using purposive sampling technique consisting of 39 (71%) male and 16 (29%) female students aged ranging from 20-22 years old. Purposive sampling technique was used intentionally because it is believed that the students have been through the main concept being studied (Creswell & Plano Clark, 2011). This is because the participants were enrolled in an English for Specific Purposes (ESP) course named English for Technical Communication (ETC) during the academic calendar semester 1, 2016/ 2017 and were using iREAD. The ESP course in the university is a compulsory English level two course taken by students as they progressed from level one of English for Academic Communication. The course involves a blended learning mode where two hours are spent in tutorial and another two in computer language labs. Normally, the first two-hour lesson is face-to-face while the second two-hour lesson is where students work on online activities. For this study, the two-hour online activities were spent on doing activities in iREAD. The activities were based on ETC module and are further described in the next section. Additionally, from this sample, a total of 12 students were purposively selected to be a part of the screen recordings of online activities. They were selected based on their participation in iREAD either being active, mediocre or non-active users. Four students were selected from each category. Pseudonyms were used for the purposes of confidentiality.

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INSTRUMENTS

Data were collected quantitatively and qualitatively through a web-based survey and screen recordings. The quantitative data was collected using a web-based survey platform named Survey Monkey. It consisted of demographic profile (i.e. age and year of degree) and five-point Likert-scale statements survey named Online Survey of Reading Strategies (OSORS) adapted by Anderson (2003). The web based survey is made up of a 36-item that measures metacognitive online reading strategies of hypertexts for academic purposes. The statements are from always (5) to never (1), which were categorized according to three metacognitive reading strategies; global reading strategies (16 items), problem solving strategies (11 items) and support reading strategies (9 items) (Appendix A). The Cronbach's alpha for the overall OSORS is 0.92 and the reliability for the Global Reading Strategies, Problem Solving Strategies and Support Strategies are 0.77, 0.64 and 0.69 respectively.

Secondly, qualitative data was collected through a screen recording software named Webinaria that captured on-screen activities to AVI files. The purpose of selecting this instrument was to observe navigational strategies that students applied while reading EST hypertexts within iREAD. The instrument enabled the researcher to observe hyperlink selection, pauses, and students' movement of cursor within an online environment in order to identify navigational patterns. This enabled the researcher to categorize the navigational strategies of the students according to the list categorized by Protopsaltis (2008).

Thirdly, was the EST text selection uploaded onto iREAD. The activities and text selection were from the ETC (see *participants*) module based on S & T topics such as technical descriptions and process explanations. The activities selected was based on Flesch Reading Ease ("Readability Formulas," n.d.) that generates the level of difficulty for each text in order to gauge students' level in reading. Table 1 illustrates the readability index.

TABLE 1. Flesch Kincaid Readability Index

Score	Description
90 – 100	Very easy
80 – 89	Easy
70 – 79	Fairly easy
60 – 69	Standard
50 – 59	Fairly difficult
30 – 49	Difficult
0 – 29	Very confusing

PROCEDURE

This section describes data collection procedure undertaken within 7 weeks of a 14-week academic calendar. During the second week, all of the students spent about 20 minutes to do OSORS during their computer lab hour. In week four, students were introduced to iREAD and were doing activities in a non-controlled environment, where the texts uploaded were randomly selected and did not fulfill any requirement such as difficult readability index (please refer to Table 1). The activities consisted of using discussion page and annotation tools to ensure students were familiarized with the e-tools in iREAD.

In week six, 12 students were selected to be involved in qualitative data collection, where screen recordings were captured while they were completing the tasks uploaded onto iREAD. The students were selected because they were either active, mediocre or non-active users of iREAD. In this week, the activities were in a controlled environment where the texts fulfilled certain criteria. The first criterion is type of text and task selected for iREAD. The texts were related to S & T topics that were obtained from the ETC module. The ETC module

was created based on S & T references and on the needs analysis of the S & T faculties in the university. These topics undergo yearly reviews by the faculties and the English department in the university. Secondly, the texts selected were based on increased difficulty readability index. The readability index for each text selected for iREAD activity was based on Flesch Reading Ease (see Table 1). For example, the text used for Page 1 was 64.5 (see Table 1), was a less difficult text for students to read. This means that the average number of words and average number of syllable per word were calculated to determine that the text was of 'standard' level for the current university students. The readability index on Page 2 and Page 3 was 54.9 and 53.9 respectively, which was fairly difficult to read. These scores made it easier to grade the text in order to ensure readability level of the texts selected for the current university students in the intermediate level. For Page 1 activity, students were required to read and highlight important ideas and points for 'reading comprehension skills and reading comprehension strategies', followed by a discussion forum on the differences between these two. The second activity was a reading comprehension activity that required students to highlight and annotate key stages. The last activity was MCQ questions based on a reading text on using a Global Positioning System (GPS). All the texts selected was measured via a web link on readability formulas obtained online that allowed the researcher to obtain the readability index automatically upon keying in the text. A summary of the activities described can be found in Table 4.

DATA ANALYSIS

Quantitative data analysis was determined through analysis of mean, median and mode in order to obtain the frequency of each sub-category. All the 36 Likert scale items from the OSORS were entered into SPSS to obtain frequency of each item. Mean ($\bar{x}$) and standard deviation (SD) for each item was computed.

Qualitative data analysis of the screen recordings made by the 12 students when using iREAD was analysed based on the navigational patterns of hyperlink selection, pauses and students' movement of cursor. These patterns determine the type of reader in an online environment as identified by Protopsaltis (2008). These patterns were then categorized for each participant based on one of the four navigational strategies for one completed lesson in iREAD.

RESULTS

ONLINE SURVEY OF READING STRATEGIES (OSORS)

Descriptive statistics were used to describe metacognitive online reading strategies students used when reading EST hypertexts. The survey of online reading strategies was classified into three parts: Problem Solving Strategies, Global Reading Strategies and Support Reading Strategies. Mean and standard deviations of OSORS are based on the each of the 36 items in the survey. Results for each of the sub parts are described in the following sections. The mean and standard deviations for the three parts of the survey are listed in Table 2.

TABLE 2. Mean and standard deviations of Online Survey of Reading Strategies

Strategies	Mean, $\bar{x}$	SD
Problem Solving	3.79	0.8782
Global Reading	3.51	0.9706
Support Reading	3.22	1.0844

Among the three types of strategies, problem-solving strategies were used the most with a mean of 3.79, followed by global reading strategies with a mean of 3.51, and support reading strategies with the least mean of 3.22. This indicates that the students mostly preferred problem-solving strategies when reading EST hypertexts compared to global and support strategies. Problem solving strategies that students used the most indicates that students work hard in trying to make meaning of the difficult online texts they encountered. This included paying closer attention to the difficult text that they read online, rereading difficult texts and getting back on track when they lose concentration. Table 3 describes in detail the top three strategies selected by students based on each sub-category of metacognitive online reading strategies in OSORS.

TABLE 3. Top three strategies for each sub-category

Metacognitive Reading Strategies	Statements	$\bar{x}$	SD
Problem Solving	26. When an online text becomes difficult, I re-read it to increase my understanding	4.40	0.78
	14. When an online text becomes difficult, I pay closer attention to what I am reading	4.26	0.72
	9. I try to get back on track when I lose concentration	4.13	0.85
Global Reading	3. I think about what I know to help me understand what I read online	4.02	0.73
	18. I use context clues (i.e. look at other words) to help me better understand what I am reading online	3.82	0.88
	24. I check my understanding when I come across new information	3.71	0.78
Support Reading	13. I use reference materials (e.g. an online dictionary) to help me understand what I read online	3.93	1.13
	23. I go back and forth in the online text to find relationships among ideas in it	3.76	0.83
	36. When reading online, I think about information in both English and my mother tongue	3.71	1.11

According to the analysis, problem-solving strategies is the most preferred strategy because most of the students answered "4" usually and "5" always for most of the strategies under this category. For example, strategy number 26 *"When an online text becomes difficult, I re-read it to increase my understanding"* was selected the most by the students with the highest score ($\bar{x}$ = 4.40). This strategy has a very high mean score because 47 students answered "4" and "5" for this strategy, which implied that students believed that they would repeatedly read a difficult online text to comprehend it. Meanwhile, global strategies were the second most preferred online reading strategy selected by students. For global strategies, students selected strategy number 3 *"I think about what I know to help me understand what I read online"* the most ($\bar{x}$ = 4.02), where a total of 45 students answered "4" and "5" for this strategy. This contributed to a very high mean score, hence, indicating the significant role of background knowledge in comprehending hypertexts for academic purposes.

On the other hand, the least preferred strategy by the students was support strategies. Among nine of the support strategies, using reference materials like an online dictionary strategy 13 *"I use reference materials (e.g. an online dictionary) to help me understand what I read online"* was a very common strategy ($\bar{x}$ = 3.93) that the students applied to understand what they read online. With 38 students that answered "4" usually and "5" always for this strategy compared to problem-solving and global strategies. Based on these results, it can be concluded that the students are able to control their reading process and take actions while reading in order to overcome reading difficulties and achieve comprehension. The notion of constructivism is displayed and achieved in the learners' ability to understand ideas

through synthesis of ideas and analysis generated through the use of iREAD, which is an online learning platform that integrated collaborative learning.

NAVIGATIONAL STRATEGIES

In order to analyze navigational strategies of students in an online environment, students were involved in completing tasks uploaded onto iREAD. Figure 3 is a screenshot of the activities numbered as Page 1, 2 and 3 on the right hand side of the screen. These numbers (1, 2 and 3) are hyperlinks that lead to an activity that the students needed to complete on the respective page. For example, when a student clicks '1' it will lead them to Page 1: Reading comprehension strategies and skills activity.

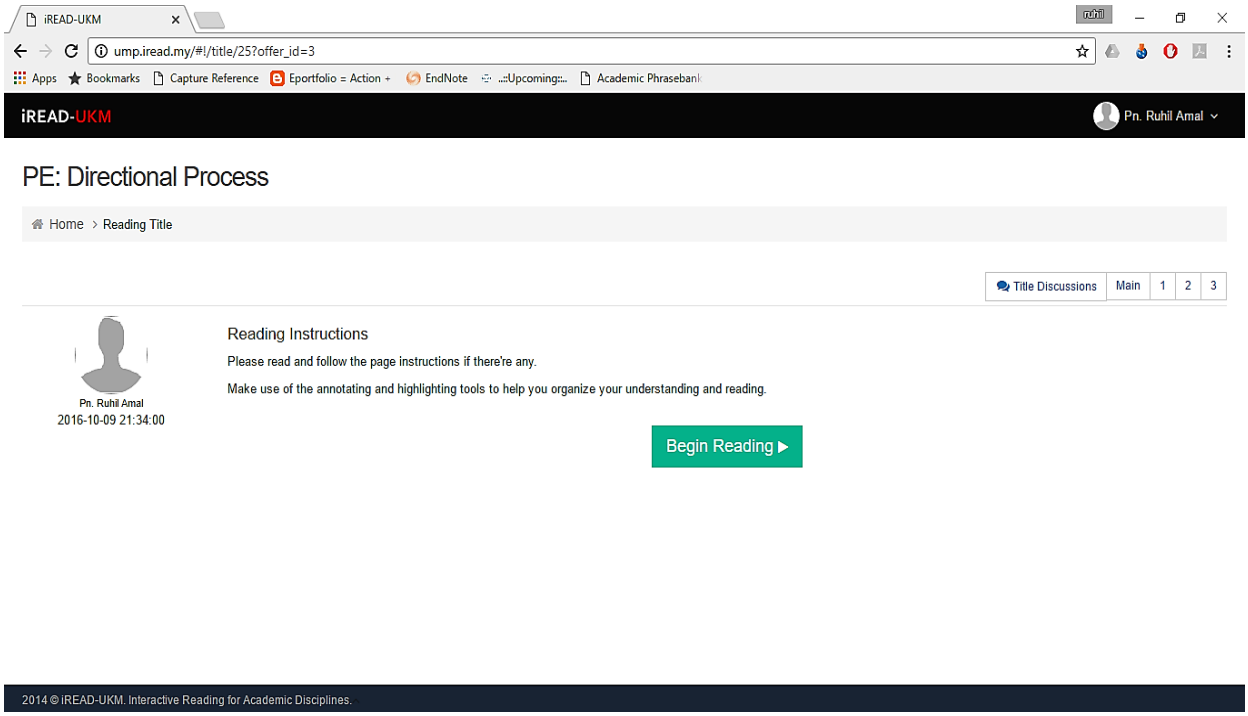

FIGURE 3. Screenshot of iREAD

Before going into detail about each screen recording, there is a need to clarify the types of online reading activities that the students were completing in each of the three pages. Table 4 summarizes the online activities that the students did in order to understand the preceding paragraphs on navigational strategies.

TABLE 4. Online activities

Page	Title	Activity
1	Reading: Strategies and Skills	Read and highlight important ideas in each subheading. Page discussion: Discuss the differences between reading comprehension strategies and reading comprehension skills
2	At the factory: From bean to bar	Highlight and annotate key stages in making chocolates
3	Reading Comprehension	MCQ on how to use a GPS

These activities were selected from Process Explanation topic in English for Technical Communication module at the university. The topic selection for the subject is in accordance to the needs analysis of the nine Science and Technology faculties at the university. Prior to the actual screen recordings, students were already trained on how to use

the platform in week 4. They were introduced to all the functionalities of iREAD, which included annotation tools, discussion page and tasks page. Activities during that week were conducted in a non-controlled environment, where the texts uploaded were randomly selected and were not of increased level of difficulty. However, the screen recordings that were made during week 6 was in a controlled environment that lasted approximately 55 minutes each.

Based on the screen recordings, the students used *mixed overview strategies* the most in dealing with EST hypertexts. This reveals that scanning took place even in an online environment, which is a strategy employed when reading printed texts. For example, *mixed overview* is called 'overview' because the readers would scan the documents to see what links were available before or during reading and selected the one to proceed with. Moreover, they proceeded with the links sometimes in a linear way and sometimes in a random way, making it a *mixed* navigational strategy. Among the 12 recordings, six students were using *mixed overview* strategy. For example, Jim began with Page 1, reading in a linear manner but while completing his task he opened a link to check his spelling and difficult words. He did this during all the activities he was completing. Another example of mixed overview navigational strategy was made by Mansor. He scanned Page 1 before doing the activity but suddenly opened a new link to look up the meaning of "mental image" that he came across. He then jumped back to Page 1 in order to complete the task. Although he did not complete all the tasks on Page 2 (figure 2) he suddenly jumped on to Page 3, scanned the page and then jumped back to Page 2 to complete the remaining task on that page. Similarly, Fatih started scanning Page 1 before reading the instructions and then started to complete the task. He then moved to Page 2, scanned the length of the passage and started reading. However, he then jumped to Page 3 without completing the task on Page 2 and scanned the passage in Page 3 looking mainly at the first paragraph to only jump back to Page 2. Overall, the data revealed that readers read in a linear and random way while also scanning the hyperlinks, making it a mixed overview strategy.

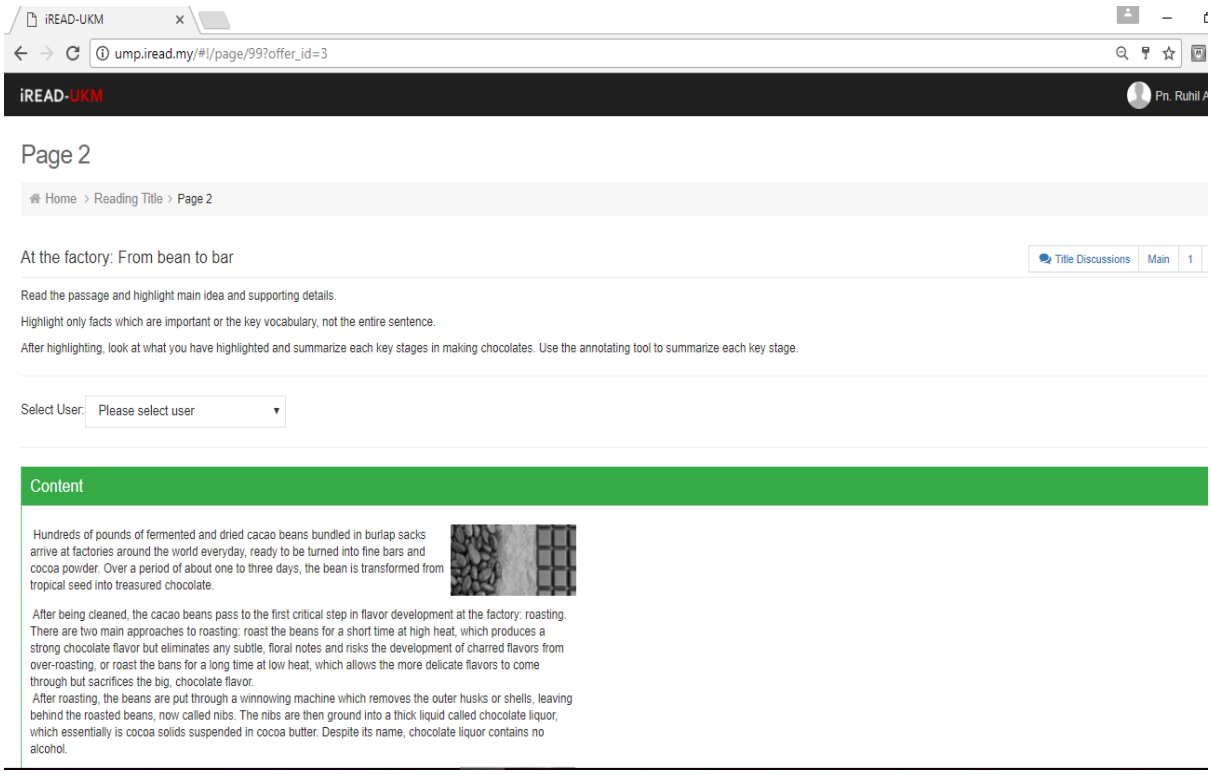

FIGURE 4. Screenshot of Page 2

The second most common navigational strategy identified was *serial overview* strategy. This strategy reflects readers who primarily read in a linear way but the difference of this strategy to that of *serial* strategy is that the readers scan sometimes before or during reading. Among the readers, four of them used serial overview strategy while navigating online. For example, screen recordings from Abu revealed that he used serial overview strategy as he began on Page 1 started to complete the task and scanned the page while completing it. He then moved to Page 2 and read the instructions carefully as can be seen in the screen recording that the cursor moved from word to word in the instruction part. He then read paragraph by paragraph and completed the task. Similarly, Faiz also used serial overview navigational strategy in reading online materials. He scanned the first activity, completed it and then moved on to the next activity. He consistently completed the tasks in a serial manner but ensured that he scanned the page first. This was seen throughout his screen recordings.

The last navigational strategy identified is *serial* strategy, where the readers read in a linear way. Only two students were found to use this strategy when navigating online. For example, Irfan is considered to use *serial* strategy when reading online texts. He consistently showed that he read the hypertexts in an orderly manner as it is presented without scanning the page. He chose to read from top to bottom in a linear way according to the presentation order of activities 1, 2 and 3. This pattern of reading was seen throughout the platform. However, all the students did not complete activity on Page 3, which was a comprehension activity. Based on the researcher's observation, students are not much interested to complete reading comprehension tasks as they are lengthy and time consuming. Figure 3 is a screenshot of the activity involved on Page 3 in iREAD. The principles behind Connectivism theory is clearly reflected by learners' navigational patterns through the online activities. This can be seen when students made connections between ideas, concepts and perspectives via iREAD in the learning process in order to construct knowledge.

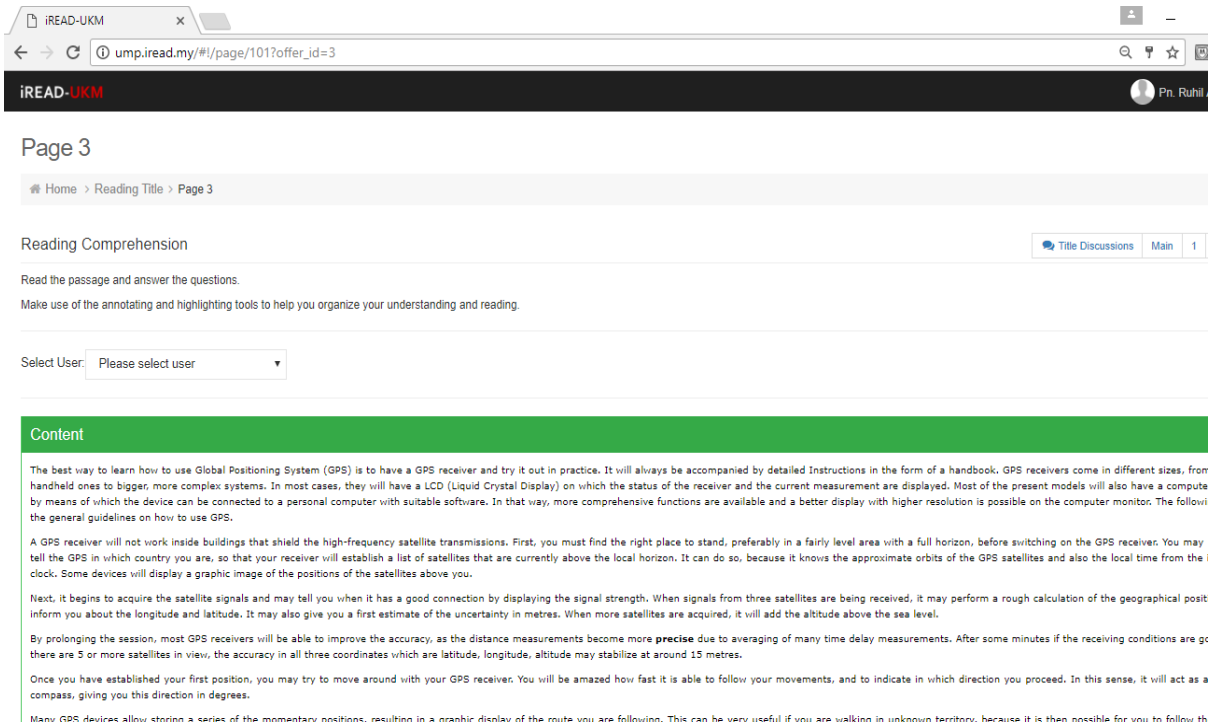

FIGURE 5. Screenshot of Page 3

DISCUSSION

The main objectives of the present study are to investigate metacognitive online reading strategies and navigational strategies of Science and Technology students in a university while using iREAD guided by constructivism and connectivism theory. The analysis shows the most reported strategy used by students is problem-solving strategies. This implies that students took actions when they were directly working with the text by adjusting their reading speed, guessing the meaning of difficult words and rereading the texts. These actions assist students to solve reading problems such as not understanding the content, main ideas or difficult terminologies in hypertexts. This is consistent with a study by Vaičiūnienė and Užpalienė (2013) who found that students would adjust their reading speed and pause to think about the academic texts they read online. This was also reported by Pookcharoen (2009) who proved that Thai EFL learners were able to control their reading by focusing on the hypertexts read and to solve problems when faced with difficult hypertexts. These are processes that would come about within ZPD of learners because they were able to annotate, view others annotations, post comments and view comments in order to complete the online tasks. All of these activities involved social constructivism and connectivism among the learners.

However, findings from the current study was not consistent with some other studies that found students used global strategies the most in reading online materials proving the need for readers to have a goal or purpose when reading online (Eghlidi, Abdorrahimzadeh, & Sorahi, 2014; Ramli et al., 2011). Eghlidi et al. (2014) found that proficient and less proficient students used metacognitive strategies differently. The study found that proficient students used more global strategies while less proficient students used more problem solving strategies. This is an indication that global reading strategies such as having a reading purpose, previewing and predicting the text are important indicators for comprehension. For example, when less proficient students have a purpose when reading, it will enable them to gauge what the text is about and to anticipate ideas. This in turn resolves reading problems for them and ultimately enhances understanding. As suggested by Ostovar-Namaghi and Noghabi (2014), this can also be done by teaching metacognitive reading strategies such as setting reading goals, using reference materials and distinguishing between fact and opinion. This should be introduced to students by including reading instruction classes at the beginning of an academic year. In other words, the current study confirmed the need to utilize metacognitive online reading strategies for academic purposes that is also reflected through social and cognitive learning processes.

The findings also show inconsistency with a study by Protopsaltis (2008) on navigational strategies, where his study found serial strategy to be used the most by students. However, results of the current study indicated that students used *mixed overview* navigational strategies the most when reading EST hypertexts. In the current study, this indicated that the act of scanning before or during reading is important for the students. This shows that students felt the need to have a general idea of the text they read and then continued reading sometimes in a linear way and sometimes in a random way. Moreover, the notion of connectivism is clearly reflected here as students constructed knowledge across networked learning communities and technologies. This is because students were able to make connections between ideas, concepts and knowledge when navigating within iREAD. A significant insight in the current study suggests that students do not transfer traditional reading strategies such as reading in a linear manner of printed texts in an online environment. As claimed by Protopsaltis (2008), students may not have relevant schemata so they are dependent on existing schemata and on familiar process (i.e. reading printed texts in a serial manner).

CONCLUSION

The findings of the current study serve to not only explore metacognitive online reading strategies, but it has also shed light on the navigational strategies when using iREAD. It can be seen that students use both metacognitive reading strategies and navigational strategies to understand hypertexts. However, students need to actually be shown how to apply online reading skills and strategies in order to enhance their online reading abilities (Sung et al., 2015). For example, lecturers can create online reading tasks to include practice on guessing difficult words through contextual clues or noting characteristics like length and organization. Such tasks would enhance metacognitive awareness of students while reading online. Hence, awareness and effective use of metacognitive online reading strategies within an online environment in teaching and learning are considered important.

However, low scores on global and support strategies implied that students need to be informed about the effective global reading strategies such as thinking about reading purposes and tapping into background knowledge for successful reading of online academic texts. Moreover, the findings suggest that there is a need for students to use metacognitive strategies to enhance their academic reading process as this will lead to better reading comprehension. In general, the participants enhanced their understanding through reading and reflective processes that is a part of constructivist learning (Ansarimoghaddam et al., 2017).

On this note, several research directions can be further explored in future studies. Firstly, the study used a relatively small group of undergraduate university students. Consequently, the conclusions should not be seen as a representative of all S & T students in the university. Further research might also focus on other levels such as master or postgraduate students. Secondly, the focus of the current research was limited to strategies used by students in an online platform. It is uncertain what students learn from the activities. Future research should focus on what students could do and learn with this particular platform. For example, understanding collaborative annotation activities or knowledge construction within discussion forums. In addition, having a better understanding of the processes involved in completing the online tasks may provide insights into how such tools can support different types of learning. In spite of the limitations, it is believed that the findings from the current study contributed to the literature regarding metacognitive awareness and navigational strategies. Therefore, in order to achieve reading goals, there is a need to teach students specific metacognitive online reading strategies (Wu, 2014) and to promote awareness through disseminating effective problem-solving strategies such as using contextual clues and rereading in order to help students become better readers of online texts.

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APPENDIX A

ONLINE SURVEY OF READING STRATEGIES

Statements	Mean, $\bar{x}$	SD
I have a purpose in mind when I read online	3.58	0.73
I take notes while reading online to help me understand what I read	2.85	1.10
I think about what I know to help me understand what I read online	4.02	0.73
I have an overall view of the online text to see what it is about before reading it	3.65	0.99
When online text becomes difficult, I read aloud to help me understand what I read	2.89	1.30
I think about whether the content of the online text fits my reading purpose	3.40	1.04
I read slowly and carefully to make sure I understand what I am reading online	4.05	0.88
I review the online text first by noting its characteristics like length and organization	3.20	1.05
I try to get back on track when I lose concentration	4.13	0.85
I print out a hard copy of the online text then underline or circle information to help me remember it	2.36	1.17
I adjust my reading speed according to what I am reading online	3.85	0.96
When reading online, I decide what to read closely and what to ignore	3.70	0.90
I use reference materials (e.g. and online dictionary) to help me understand what I read online	3.93	1.13
When online text becomes difficult, I pay closer attention to what I am reading	4.25	0.72
I do a lot of reading on the internet for academic purposes	3.05	1.05
I use tables, figures and pictures in the online text to increase my understanding	3.55	1.25
I stop from time to time and think about what I am reading online	3.33	0.95
I use context clues (i.e. look at other words) to help me better understand what I read online	3.82	0.88
I paraphrase (restate ideas in my own words) to help me better understand what I am reading online	3.35	0.99
I try to picture or visualize information to help me remember what I read online	3.84	0.93
I use typographical features like bold face and italics to identify key information	2.95	1.27
I critically analyze the information presented in the online text	3.36	0.79
I go back and forth in the online text to find relationships among ideas in it	3.76	0.83
I check my understanding when I come across new information.	3.71	0.78
I try to guess what the content of the online text is about when I read.	3.71	1.04
When an online text becomes difficult, I re-read it to increase my understanding.	4.40	0.78
I ask myself questions I like to have answered in the online text.	3.15	0.85
I check to see if my guesses about the online texts are right or wrong.	3.58	0.97
When I read online, I guess the meaning of unknown words or phrases	3.74	0.93
I scan the online text to get a basic idea of whether it will serve my purposes before choosing to read it.	3.65	0.99
I read pages on the Internet for fun	3.20	1.07
I critically evaluate the online text before choosing to use information I read online.	3.16	0.89
I can distinguish between fact and opinion in online texts.	3.58	0.82
When reading online, I look for sites that cover both sides of an issue.	3.31	0.95
When reading online, I translate from English into my native language.	3.00	1.28
When reading online, I think about information in both English and my mother tongue.	3.71	1.11

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ABOUT THE AUTHORS

Ruhil Amal Azmuddin is a Ph.D candidate in English Language Studies in Universiti Kebangsaan Malaysia. She is a university lecturer in Centre for Modern Languages and Human Sciences, Universiti Malaysia Pahang. Majoring in TESL and TESOL, she obtained her Masters in Educational Studies from University of Newcastle, Australia and her B. Ed (Hons.) TESL in Universiti Teknologi MARA, Malaysia. Her main research interests are reading in ESL, Computer Assisted Language Learning and online reading.

Nor Fariza Mohd Nor (Ph.D) is an Associate Professor at the Sustainability of Language Sciences Research Center, UKM. Her research interests are critical discourse analysis, digital communication and digital humanities. She is currently involved in corpus linguistics and inter-religious discourse research.

Afendi Hamat (Ph.D) is an Associate Professor at the Sustainability of Language Sciences Research Center, UKM. His research areas are e-learning and web-based CALL. He has developed various e-learning platforms such as the Second Language Instruction and Management System (SLIM) and the intelligent English Language Literacy System (i-ELLS). He also designed i-Folio, the successful hybrid LMS currently used by UKM.

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