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It's All about Strategy Choices When Three EFL Undergraduates Read Two Scientific Texts: A Qualitative Insight

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Abstract: This is a qualitative study that looks into theinterplay of crucial variables in the successful comprehension of two scientific texts of different topic familiarity and syntactic difficulty. Respondents were three EFL undergraduates with some prior knowledge on the two scientific texts but different levels of English proficiency. The aim was to see how they negotiate the two texts given their current level of English proficiency and prior knowledge. For this purpose, think aloud protocols and structured interviews were conducted to determine their strategy choices. The study shows that even though L2 proficiency and prior knowledge of the science topic are important contributors, strategy choices are instrumental to successful comprehension. While lower cognitive strategies are used to get the meaning from the written texts, it is crucial to use higher cognitive strategies to complete the understanding.

Key words: EFL learners, second language reading, scientific texts, cognitive and metacognitive strategies, think aloud protocol

INTRODUCTION

In the many fields of science, English has long been recognized as the predominant medium of international discussions amongst the scientific communities. It is estimated that more than half of the scientific literature produced worldwide are reported and published in the English language (Swales, 1990). As a result, English has become the second language of the world nations and reading efficiently in this language is a must in order to enable scientists to communicate ideas and break throughs with their counterparts all over the world.

Scientific texts with its complex syntax, long sentences and field specific terminology are very challenging reading texts for EFL learners (Amer, 1994). Studies conducted on EFL undergraduates (Goh, 2004) revealed that they continued to have serious problems in reading English academic texts in their first year at the university. While many studies suggested that poor English language proficiency was responsible for the difficulty in the reading comprehension of English texts (Chen and Donin, 1997; Harvey, 2005; Hock, 1992), others blamed it on inadequate practise (Cooper, 1984), lack of reading skills and strategies (Shih, 1992) and lack of reading perseverance (Sargunan and Nambiar, 1994). Nevertheless, self-initiated independent reading of printed as well as online references and professional journal articles is pertinent and crucial to tertiary level academic success (Flowerdew, 1993; Koda and Zehler, 2008) and ought to become a second nature to these ESL science undergraduates as a regular reading routine.

Literature review: According to Goodman (1988), reading is as much about decoding the language of the text as it is about the involvement of the writer's and reader's thoughts. As the reader decodes the language, s/he will simultaneously begin to construct the intended meaning of the writer by integrating the information with his/her prior knowledge and thus forming a model based on the text content (Dijk *et al*., 1983). The process of reconstructing meaning is a complex yet extremely dynamic cognitive activities (Pressley and Afflerbach, 1995). As the reader's eyes fall onto the printed words, several knowledge sources like lexical knowledge, syntactic knowledge, semantic knowledge (Stanovich, 1980) as well as prior knowledge (Carrel and Eistherhold, 1983, Nassaji, 2002) will act concurrently on the information provided by the text. While reading is in progress, readers may wish to optimize the integration of meaning between the data in the text and the information they possess. Alternatively there may be a breakdown in the information provided by one or more knowledge sources mentioned above and thus comprehension of the text is at stake. In these circumstances, the readers may take certain deliberate actions known as comprehension strategies to maximize understanding or resolve comprehension difficulty. These actions are cognitive strategies employed by readers to process the input from the texts in either L1 or L2.

Brantmeire (2002) maintains that these cognitive strategies are also specific "attacks" that readers opt for when faced with a challenging text and more so when

encountering comprehension difficulty while progressing through it. Unlike reading skills which imply what a reader can do (Koda, 2005; italic original) during a reading process like decoding skill, automatic word recognition skill and even summarizing and paraphrasing skill, comprehension strategies entail what a reader plans to do or intends to do (ibid; italic original) when s/he encounters different types of texts or faces reading difficulties.

Readers' strategy selection and change are thus influenced by the fact that the process of reconstructing meanings of texts varies from one type of discourse to another (Henia, 2003) due to the complexity of the language structure or the inadequate language and prior knowledge of the readers. Thus, to maximize the extraction of meaning a reader normally employs comprehension strategies or a combination of strategies consistently during a reading process. Familiarity with the language and content of text may lead to the employment of higher-level cognitive strategies which focus on conceptual processing of the text. Alternatively, the same reader may opt for lower-level strategies and focus her or his attention on language based processing when confronted with more linguistically or conceptually challenging texts. The shifts in focus and strategy use while reading reflect the reader's current language competence especially her or his decoding and word recognition skills. Hence, reader's selection of employing lower or higher level cognitive strategies is primarily the result of her or his conscious decision during reading (Koda, 2005) based on the types of texts on hand.

A review of the literature on foreign and second language reading strategy research indicates that comprehension strategies are grouped into different categories. Block (1986) categorizes reading strategies into two groups which are general and local strategies while others label similar strategies as global and local strategies (Brantmeier, 2002; Young and Fry, 2012). Local strategies are more focused on attempts to understand specific linguistic units such as solving vocabulary problems and questioning meaning of a clause or sentence. General and global strategies include steps taken to conceptualize the meaning of the content and actions employed to monitor comprehension of the text.

Chamot and O'Malley grouped strategies into cognitive and metacognitive strategies. Cognitive strategies are steps taken to comprehend materials such as inferencing, guessing meaning from context, summarizing, rereading and relating new information to prior knowledge or content schemata. Metacognitive strategies are steps related to self-management or self-regulation of those cognitive strategies while reading which include planning and monitoring strategies. The strategies employed by readers are primarily governed by two variables which are language proficiency and prior knowledge of the readers. Thus, this study was aimed at getting some insights into how EFL learners read to comprehend two scientific texts.

Research question: How do EFL readers with different levels of English language proficiency and science prior knowledge read to comprehend two scientific texts?

MATERIALS AND METHODS

Research design: This study employed a concurrent triangulation mixed method research design where data was collected through quantitative survey as well as qualitative techniques. This design was adopted so as to get an in-depth understanding to the research problem which was strategies choices made by EFL learners in reading scientific texts. However, for this article, only the data from the qualitative phase are discussed.

Respondents: Only five out of ten respondents chosen for the qualitative phase remained until the end of the study. They were EFL undergraduates who enrolled for a biology degree programme and were in their second semester when the study was conducted. For this article, only three of the qualitative respondents will be reported as they managed to capture the essence of reading scientific texts in their strategy choices. They were between 19-22 years old with English language (L2) proficiency ranging from limited users (band 2) to competent users (band 4) based on the result of the English language entrance test for Malaysian university (MUET).

Research instruments: There were five instruments used for this study. First was the scientific texts. Two scientific texts used in this study were from college biology textbooks. Biology was chosen over chemistry or physics because biology literature consists of both verbal and figural content which were relevant to the study that examines reading comprehension of scientific texts. Scientific texts A and B had a readability index of 12 on the Flesch Kincaid Index. Text A contained 592 words with 20% passive construction while text B had 744 words with 30% passive sentences. Text A entitled Auxins and Elongation of Cells (Campbell *et al*., 2000) consisted at least 50-60% known concepts to first year science undergraduates. Text B entitled Hormones and Signal Transduction (Boyer, 2006) was estimated to carry about 20-40% of known scientific concepts. Baker and Brown (1984) argued that efficient learning entails active monitoring of one's own cognitive processes in a continuing effort to solve reading problems. Hence, it is crucial to choose texts of 'intermediate difficulty' because if the reading task is too easy, readers may not bother to

strategize but if it is too difficult, they may give up (ibid). The two texts were deemed of 'intermediate difficulty' level and appropriate for the target respondents.

The next instrument was reading comprehension questions for texts A (RCA) and B (RCB). RCA and RCB contained 33 and 36 multiple choice questions respectively and one short summary on the biochemical process mentioned in the text. A written summary was used as an instrument to assess comprehension since it encourages readers to attend to the thesis of the text as the major focus, organize in a personal way and relate to the prior knowledge they already possess (Alderson and Lyons, 1996). In addition, summarizing requires participants to utilize their higher level skills of analyzing, evaluating and synthesizing to comprehend the text (Oded and Walters, 2001). The total possible score for RCA was 61 marks and for RCB 58 marks.

Another instrument was the Metacognitive Awareness Inventory (Schraw and Dennison, 1994) with a reliability alpha of 0.956 to assess respondents' metacognitive awareness. MAI assesses various aspects of metacognition such as knowledge of cognition (declarative, procedural and conditional) and regulation of cognition (planning, monitoring, debugging, evaluation and information management). Respondents gave feedback to each item on a 7-point scale ranging from strongly disagree (1) to strongly agree (7).

The last instrument was a demographic survey that enquired about their L2 proficiency, biology grades obtained in the first semester, their prior knowledge of scientific topics likeplant and human hormones andsignal transduction, and finally their Cumulative Grade Point Average (CGPA).

Reading strategies were assessed through the use of think aloud protocol where respondents for the qualitative phase were asked to read the text aloud and verbalize any thinking that was going on while they were reading the scientific texts. The verbal information uttered by the respondents was recorded using a digital voice recorder to be transcribed and analysed.

Procedure: Three think aloud training sessions were held two weeks prior to the actual data collection. During the actual data collection, the researcher met with each respondent individually on two separate days according to an agreed schedule. Each respondent was asked to read one of the two scientific texts on each meeting.

On the first meeting, the respondent was given a practice text to practice thinking aloud for about 15 min. When he or she was ready, the first scientific text (which could either be text A or B) was given to be read aloud for comprehension. The respondent was also told that comprehension questions would follow soon after the reading session. Scientific texts for the think aloud protocol were marked with this symbol yat the end of every two or three sentences (Thoreson *et al*., 1997) to remind the respondent to stop at the end of the sentence and verbalize his or her current thoughts on the text/diagrams/prior knowledge.

Each respondent's think aloud protocols were recorded using digital voice and video recorders. After reading the first text, s/he was giventhe instrument MAI to act as a buffer to reduce the effect of memorization if s/he had memorized any part of the reading text. Upon completion, reading comprehension questions were given. Retrospective interview followed soon after that. The same procedures were repeated in the following data collection meeting when they read the second scientific text and answered reading comprehension questions based on the text.

RESULTS AND DISCUSSION

Table 1 shows the variables that contribute to the reading processes and comprehension of the two scientific texts by 3 respondents. Only three out of five respondents were chosen for this analysis as they exhibited interesting strategy shifts from one text to the other.

EFL learner's variables: Scientific Prior Knowledge and L2 proficiency: Among the three respondents, Di An was a competent English user with band 4 out of the 6 possible bands in MUET while Az a modest user (band 3) and Zeti a limited user of English (band 2). On their prior knowledge of the topic Auxin (text A), Zeti had the most knowledge while for a biochemical process called signal transduction (text B), Az had the most knowledge.

Metacognitive awareness: Di An scored the most on Metacognitive Awareness with 317 while Az scored second highest with 287. On the other hand, Zeti scored the lowest with 258. Zeti's score matched the scores obtained by undergraduates in the USA with 254 (Coutinho, 2007) and 251 (Coutinho and Newman, 2008).

Reading comprehension scores of text A: Of the three respondents, Zeti whose L2 proficiency was most limited, scored the highest with 45%, and above the mean (M = 42%) scored by the total respondents (N = 333) for this study. Looking at her prior knowledge on the topic may explain why she managed to understand the text better than the other two respondents. Di An with better L2 proficiency than Zeti did not manage to process the text as well as Zeti. Understandably, Az scored the lowest since she had nothing going for her, netiher her L2 proficiency nor her prior knowledge on the topic auxin. This may be one small evidence to suggest that when

Table 1:Three EFL learner's variables and their reading comprehension scores of two scientific texts

	Scientific text A (Auxin) M = 42%			Scientific text B (Signal transduction) M = 37%		
Variables	Di An	Az	Zeti	Di An	Az	Zeti
MUET band/L2	Hi -4	Low - 3	Low -2	Hi -4	Low - 3	Low -2
PK	Low	Low	Hi	Low	Hi	Low
MAI score	317	287	258	317	287	258
RC score %	42%	35%	45%	32%	46%	43%

Learner's variables; MUET-Malaysian University English Language Test to assess L2; PK-Prior Knowledge- Biology grade obtained in STPM/Matriculation; MAI-Metacognitive Awareness Inventory

Table 2: Three EFL learner's strategies and their reading comprehension scores of two scientific texts

Metacogitive awareness/	Scientific text A (Auxin) M = 42%			Scientific text B (Signal transduction) M = 37%		
Strategy Freq	Di An	Az	Zeti	Di An	Az	Zeti
MAI score	317	287	258	317	287	258
MC strategies	44	101	54	45	70	63
HC strategies	74	53	88	54	89	63
LC strategies	174	120	128	65	55	96
RC score %	42%	35%	45%	32%	46%	43%

PK-Prior Knowledge; Biology grade obtained in STPM/Matriculation; MAI-Metacognitive Awareness Inventory

Reading comprehension scores of text A: Of the three respondents, Zeti whose L2 proficiency was most limited, scored the highest with 45% and above the mean (M = 42%) scored by the total respondents (N = 333) for this study. Looking at her prior knowledge on the topic may explain why she managed to understand the text better than the other two respondents. Di An with better L2 proficiency than Zeti did not manage to process the text as well as Zeti. Understandably, Az scored the lowest since she had nothing going for her, netiher her L2 proficiency nor her prior knowledge on the topic auxin. This may be one small evidence to suggest that when one knowledge source fails to help a reader to comprehend a text, s/he may compensate that deficiency by relaying on other knowledge resources such as her/ his prior knowledge to help unpack the meaning of the text. one knowledge source fails to help a reader to comprehend a text, s/he may compensate that deficiency by relaying on other knowledge resources such as her/ his prior knowledge to help unpack the meaning of the text.

Reading comprehension scores of text b: For text B which is more difficult to comprehend than text A, the mean score obtained by the total respondents (N = 333) was 37%. Az scored the highest marks among the three respondents in the qualitative study with 46% which was also 9% higher than the mean. Di An, on the other hand, scored only 32%, lower than the mean of the total population of the study. Interestingly, Zeti whose linguistic knowledge was two band lower than Di An and like Di An had low knowledge on the topic signal transduction managed to score higher than Di An with 43%. The first assumption made above about having a prior knowledge could help compensate linguistic deficiency may still hold true in this situation. Az whose knowledge of signal transduction was high, scored high marks in the reading comprehension of text B despite her L2 proficiency.

However, it is interesting to note that Zeti whose L2 proficiency and prior knowledge on the text B were both low compared to Di An who at least possessed higher L2 proficiency managed to outperform Di An in both reading comprehension of two scientific texts. So, could it just be that Zeti was a better reader than Di An?

Table 2 shows the type and frequency of strategies used by the three respondents while reading the two scientific texts. This data was obtained from the think aloud protocols of each respondent.

MC strategies: Meta Cognitive strategies are those that readers use to manage and regulate their cognitive processes during reading such as planning the next move, previewing or over viewing, solving confusion, checking understanding and monitoring comprehension. Di An's metacognitive awareness score was the highest among the three respondents, yet the frequency of her using metacognitive strategies was the lowest at only 44 and 45 times for tests A and B respectively.

Az, on the other hand had a frequency of 101 MC strategies on a text that she had low prior knowledge but greatly reduced it to 70 on a text that she had high knowledge. Could this mean that she had less problems when reading a text she was familiar with thus less number of MC strategies? Perhaps she had a lot of comprehension problems while reading text A which topic she had less prior knowledge on.

Zeti whose MAI score was the lowest among the three respondents maintained about the same number of MC strategies for both texts, perhaps a little higher for text B, a text of more syntactic difficulty and a topic which she had less knowledge on.

HC strategies: Higher cognitive strategies are attempts that focus on synthesizing the information from various sources in order to comprehend the text content. Zeti used the most number of HC strategies (88) for text A and reduced it to 63 for text B. Zeti did very well for text A but obtained lower score for text B. In contrast, Az used the least HC strategies (53) for text A and the highest for text B (89). The result seems to suggest three things. One, if one has high prior knowledge, the employment of HC strategies are also high. Two, the result suggests that a high usage of HC strategies may lead to better comprehension. Third, the employment of the right strategy may lead to better comprehension even though one is lacking in L2 proficiency and prior knowledge.

LC strategies: These are lower level strategies that focus on unpacking the difficult language and sentence structures. To assume these are poor strategies may be groundless since Zeti who employed as many as 128 LC strategies managed to outperform more L2 proficient readers like Di An and Az. Yet to conclude that one must employ many LC strategies to successfully comprehend a text is also misleading since Az employed the least LC strategies in reading text B and scored the most in reading comprehension assessment. Therefore, what is the role played by these strategies?

Strategies are personal cognitive tools which one uses while performing challenging tasks such as reading scientific texts. While one could not control his learner's variables (level of L2 proficiency and his knowledge of the topic) to be a good match to the text, he can certainly choose specific efficient strategies that could assist him to understand the text.

From the findings, Zeti seems to understand herself the best compared to the other two EFL learners. Her MAI score is similar to the score obtained by respondents in other studies which indicates that she answered the questions as she sees fit and not to please the researchers. Second, she understands which strategies work for her. Thus, even though text B is a more difficult text in terms of language and topic, she chose to use less LC and HC strategies since she was lacking in both but she monitored her understanding of the text more by employing more MC strategies.

Similarly, Az chose to use more top down processing by employing HC strategies since she could rely on her prior knowledge to comprehend the text. However when she lacked prior knowledge such as when she was reading text A, she fell back on her LC strategies. It was a bad move since 50% of her LC strategies were not complemented by her more efficient HC strategies.

CONCLUSION

From the research, it is evident that L2 proficiency and prior knowledge of the topic are not the sole contributing factors for better comprehension of an L2 scientific text. This is especially true for reading for academic purposes where the ultimate goal is to comprehend the content. Correct strategy choices are instrumental to better comprehension of an L2 scientific text. It is also evident from the study that readers must learn and observe what contributes and what does not contribute to their reading comprehension.If EFL learners are metacognitively aware of their reading processes, they will learn which strategies work for them and make the correct choices all the time.

RECOMMENDATIONS

EFL learners must learn and adopt the three types of reading strategies in order to understand academic texts better. Science instructors or English language teachers must introduce reading strategies to students as early as the first semester at the university. This skill would assist EFL learners to become better readers and ultimately become life- long learners.

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