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Cognitive demands of processing expository text: Pedagogical implications for enhancing coherent text base among less skilled readers

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Abstract

This study investigated the effects of cognitive load in the processing of expository text between skilled and less skilled readers from three selected Junior High Schools in one Municipality in Ghana. The findings of this study show consistent pattern of differences between skilled and less skilled readers when tested on item difficulty as function of abstractness along five variables and item difficulty as degree of inference along four variables: the more difficult the task given to the two groups, the wider the performance differences across the different variables between them. This was interpreted as cognitive load effect: whereas some tasks may facilitate a particular type of text comprehension, others may not be that effective especially for less proficient readers. Unlike skilled readers whose lower-level processes are well automated, the poor readers in this experimental study allocated more attention to lower processes and consequently attention allocation to higher mental process and global text features was impaired. Instructional implications for enhancing coherent text base among less proficient readers are suggested.

Keywords: cognitive load; expository text; pedagogical implications

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1. Introduction

Research in reading comprehension suggests that successful reading of a text is not always contingent upon word identification skills. Indeed, it is not always the case that individuals who are good readers are necessarily good passage comprehenders (e.g., Cain & Oakhill, 2006; Catts, Adlof, & 2006; Cutting, Materek, Cole, Levine, & Mahone, 2009). This support the idea that reading comprehension is much more complex, requiring both the coordination and the integration of other components of cognitive skills over and above single word identification. Skilled reading is considered a highly complex capability and some researchers' categorize the processes involved into four groups: decoding, literal comprehension, inferential comprehension and comprehension monitoring. It is assumed that all these cognitive processes are likely to be going on in parallel during reading (Federiksen, 1982; Thibadeau, Just, & Carpenter, 1982).

Comprehending scientific and technical expository text is a cognitively demanding task for at least two fundamental reasons. First, the reader must possess and be able to call upon large bodies of specialized knowledge. Second, the reader must be able to concurrently carry out a variety of *component reading processes* as well as *memory management processes*. The main claim of this study is to find out whether or not the comprehension of expository text can be enhanced by removing from the reader some of the cognitive load imposed by these processes. The component reading processes discussed in this study include the following: word recognition, calling up the meaning of words, parsing sentences, and integrating text. Text integration process is the most important because it produces the cognitive structures that are the desired end product of reading. It is for this reason that text integration is referred to as higher-level component process, while the other component processes are called lower-level. Executing any of these component processes involves a series of cognitive (mental) operations and these operations simultaneously use the resources of the limited cognitive structure of the short term memory/working memory.

The Short Term Memory (STM) is assumed to be heavily constrained in terms of capacity and duration (assuming conventional estimates of 20 seconds duration and seven chunks of information capacity are correct), it is most often unable to hold at once all component processes and prior knowledge used in reading. Therefore, extra cognitive processes are required to manage the short term working memory store. These extra cognitive processes are called *memory management processes.* The management process includes the following: moving cognitive programme and prior knowledge rapidly out of working memory as they are needed by the various processes that are being executed. Thus these memory management processes themselves use cognitive resources and so make additional demands on the cognitive system (Bruce, Shawn, Glynn, & Jeffrey, 1985).

Typically, expository text compared with narrative appears to present additional demands on the human cognitive architecture. This is because the former type of text unlike the latter does not present a consistent structure especially those containing diagrams. Consequently, this complex nature of expository text as well as the explanatory diagrams and other text genre presents extra cognitive load to the reader. Narrative text, on the other hand tends to be presented and read in a more linear fashion whereas expository text with diagrams may also be presented in a linear format regarding the main text but other aspects are non-linear and this may present some challenges to readers. This becomes challenging for non-skilled readers because they need to reconstruct the content, and make connections that will make it possible to organize the text so that meaning could be created.

1.1 Statement of problem

In the basic schools, instructional content is by and large skewed towards narrative texts (Duke, 2000). However, as students go through academic progression from basic schools towards senior high and tertiary institutions, they are more and more required to engage with expository texts especially in content areas as science rather than narrative. In this respect, when at the basic level of school, students have insufficient exposure to expository text, this already sets constraints, and limiting opportunities for high level education (cf. Martin & Duke, 2011). This is even more compelling in geo-political areas where most students from less endowed backgrounds lack both the cultural and literate capital associated with proficiency readers and additionally have English for example as second language. Such students are more disadvantaged compared with those with foundational exposure to expository text. They are unable to transfer foundational skills and strategies to engage text comprehension (cf. Tunmer, Nicholson, Greaney, Prochnow, Chapman, & Arrow, 2008). In this respect, low level achieving students struggling to master foundational reading skills find themselves faced with another load. This inability to gain meaning from expository structures tends to have negative impact on students success in other content areas- the so-called- 'Matthew Effect' (Stanovich, 1986). This 'Matthew Effect' causes the inability to access these texts, reducing exposure to content area knowledge as well as opportunities to build on prior knowledge and vocabulary.

In Sub-Sahara Africa, for example, optimizing learning and education at the basic level is largely language-related. Research evidence shows that the English-medium education in African schools with learners whose English language ability is low impedes learning (Macdonald, 1993; Rubagumya, 2003). In contrast, learners and teachers who use the mother tongue medium education (MTE) enhances teaching while learners learn more effectively (Heugh, 2006). Research from around the world has confirmed that literacy is fundamental to success in the formal education system. Good, Gruba, and Kaminski (2001) have noted that learning research shows that children who develop good reading skills are more likely to succeed at school and become productive members of our society.

Globally, UNESCO report showed two hundred and fifty million (250,000,000) children of school age cannot read or write, whether they are in school or out of school (http://www.unesco.org). The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), in its 2007 assessment in fourteen countries, highlights acute deficits in learning achievement in several participating countries. For instance, in Malawi and Zambia, over a third of grade 6 students failed to acquire the most basic literacy skills. (http://unesdoc.unesco.org/images/0019/001913/191393e.pdf.) All the above notwithstanding, not many studies have been conducted in most parts of Africa to find out the psychological precursors to reading deficiency among children on the continent and in Ghanaian basic schools. It is within the context of this lacuna that this study was undertaken.

1.2 Research objectives

Based on the above defined problem, two key objectives that guided this study were:

- To find out whether or not the comprehension of expository text requires more processes than word identification among basic school children in Ghana.
- To examine whether or not the comprehension of expository text can be enhanced by removing from the reader some cognitive load imposed by other processes than word identification.

1.3 Research questions

The key questions then that this research investigated were:

- Does the comprehension of expository text require other mental processes than word identification?

- Can the comprehension of expository text be enhanced by removing from the reader some cognitive load imposed by other processes than word identification?

1.4 Significance of the study

Mastery of literacy skills, especially reading deficiency has been reported as one of the major setbacks in Sub-Sahara Africa's quest for quality education within the context of the Education For all (EFA) agenda. Achieving measurable outcome in literacy especially literacy and numeracy has become essential. Nevertheless, EFA Global Monitoring Report issued by UNESCO reports that access and the right to education have overshadowed the attention to quality — how much and how well children learn and the extent to which their education translates into a range of personal, social and developmental benefits. It is in this respect that The Dakar Framework for Action in 2000 has emphasized quality as basic determinant of EFA. This commits nation to ensure primary education is of good quality in respect of better cognitive and non-cognitive outcomes (Ghartey, 2010). Assessing learning achievement indicate that African countries are among countries with less than 50% of its children achieving literacy, numeracy and life skills mastery.

As far back as 1994, the Criterion-Referenced Testing (CRT) in Ghana showed that grade 6 pupils' performance in literacy skills was poor. Several studies in Ghana confirm that this failure of Ghanaian pupils to learn English may be attributed to poor quality of pedagogical methods. Dzameshie (1997) sees teaching of English in Ghanaian schools as more analytical and grammar-based. Similar concern was expressed as far back as 1972 describing Ghanaian teaching methods as 'traditional', 'whole class' and 'teacher dominated'. Other recent Ghanaian studies report that many children in Ghanaian public basic schools have learning difficulties especially dyslexia in the Greater Accra region of Ghana: 75% of teachers and 80 % of head teachers who took part in a survey admitted respectively of their pupils having problems with reading (Special attention Project, December 2011).

Given the above scenario, this study therefore will be significant to stakeholders in pre-tertiary education in Ghana such as the Ghana Education Service, basic school teachers, and parents', students of Colleges of Education in our universities. An understanding of the psychological mechanisms that underlie reading comprehension in children is likely to contribute to the effective ways to enhance pupils/students' ability to draw inferences in reading. Besides, it would contribute to enhancing teachers' pedagogical skills in the teaching of English as a second language and capitalize on classroom learning opportunities.

2. Literature review

2.1 Characteristics of proficient readers

Reading comprehension is a complex process. Research has revealed these simultaneous interactive processes by examining the skills and strategies of skilled readers and less skilled readers and why the former are able to perform better than the latter (Pressley & McCormick, 1995). Notwithstanding the variability across proficient readers, there are certain attributes that all good readers possess (Fountas & Pinnell, 2002; Sweet & Snow, 2002) such as automatic decoding, using various strategies to engage text, setting strategic goals and self-regulation etc. In addition to being able to automatically decode text, proficient readers actively engage text using many strategies. For example, Duke and Pearson (2002) make the submission that good readers are active; they set goals for reading and evaluate their progress towards the goal; they attend to important information in text; they ask questions about aspects of the text and try to predict what is to come next; they read selectively paying attention to important parts of the text; they use prior knowledge to understand and integrate new information they encounter; they construct summaries of what they have read, and they monitor their understanding of the text and modify the strategies they are employing based on that understanding.

Proficient readers tend to be more strategic and self-regulated when reading both narrative and expository text, even though some comprehension strategies are particularly applicable to expository text. When reading expository text, good readers, unlike poor readers recognize common expository text patterns, such as comparison or causation, and are able to use text structure schemata to help them understand and remember information in the text (Chambliss, 1995; Meyer, Brandt, & Bluth, 1980). The knowledge of text structures allows proficient readers to construct mental models of the salient ideas presented in expository text, enabling them to learn and remember information (Meyer et al., 1980). Because expository text tends to be more complex than narrative, proficient readers of informational text generally tends to have metacognitive abilities, that is they have knowledge about their own cognitive processes and are therefore capable of monitoring their reading and are able to regulate those processes during reading (Baker & Brown, 1984; Flavell, 1979). Thus proficient readers regulate their own reading by setting reading goals; they monitor their understanding by thinking about how information they are encountering in the text fits with what they already know about the topic. Readers who adequately monitor their comprehension also are able to employ control, or fix-up strategies, such as rereading or asking themselves questions, when they notice comprehension breakdowns (Samuels, Ediger, Willcutt, & Palumbo, 2005).

2.2 Cognitive demands

Recent research developments have highlighted the fact that demands imposed by particular task can either enhance or inhibit cognitive processing (Robinson, 2001; Skehan, 1998). While some tasks may enhance the reading of a particular text, others may not be particularly effective for a reader (L2) whose native tongue is not English and therefore lacks enough fluency to construct local text meanings and put local information together. Such readers are more likely to be preoccupied with lower-order processes such as decoding and syntactic parsing (Grabe, 2009). Linguistic aids for example glossing and text manipulation for such L2 readers tend to be beneficial because they ensure sufficiency in coherent text base (Leow, 2009). However if these low-order processes are automated sufficiently enough, large space in the Working Memory can be allocated for other higher mental processes in reading.

2.3 Expository text

Text genre can also have impact on reading comprehension. For example, expository text, as opposed to narrative prose or written stories, is nonfiction text. It is written to provide information and explanation (Graesser, 1981) making it differ significantly from narrative text (Dole, Duffy, Roehler, & Pearson, 1991; Fang, 2008). Expository text is therefore structurally more complex and has more information than narrative text (Stein & Trabasso, 1981). In addition, expository text sounds less familiar, often broaches topics where students usually have less prior knowledge, and generally includes more complex text structure combinations (Fang, 2008). The ability to comprehend and learn from expository text is critical for students success in school and for life-long learning (Durkin, 1993), yet narrative text often makes up the bulk of reading for early elementary age students (Duke & Pearson, 2002). Expository text is often introduced when students make the transition from "learning to read" to "reading to learn" (Chall, 1983). This generally occurs after the third grade (Fang, 2008; Williams, Hall, Lauer, Stafford, DeSisto, & deCani, 2005).This transition also seems to occur about the same time as the "fourth-grade slump," a period where students who were progressing as readers suddenly seem to fall behind (Chall, 1983; Chall & Jacobs, 2003; Chall, Jacobs, & Baldwin, 1990). The introduction of expository text, containing more difficult vocabulary and information and requiring more background knowledge for understanding, may be a contributing factor to this slump (Dole et al., 1991).

Many students generally tend to have some difficulty understanding, remembering, and learning from expository text, not just elementary-age students, or students who have been identified with comprehension problems (Reutzel, Camperell, & Smith, 2002; Wiley, Griffin, & Thiede, 2005; Williams et al., 2005). In addition to the structural complexity of expository text (Armbruster, 1984; Reutzel et al., 2002), Williams, Taylor, and deCani (1984) also made the claim that expository text is more difficult to comprehend because many of the

conceptual relationships contained in this type of text are implicit and therefore must be inferred by the reader. Readers may also have more difficulty determining text structure when reading expository text because informational text often contains combinations of two or more text structure types (Meyer & Poon, 2001), including description, sequence, problem-solution, compare-contrast, and cause-effect (Anderson & Armbruster, 1984; Meyer & Freedle, 1984; Meyer, Theodorou, Brezinski, Middlemiss, McDougall, & Bartlett, 2002).

Kucan and Beck (1996) examined the effect of genre, both narrative and expository, on reading comprehension. The researchers had fourth-grade students think aloud about their online comprehension while reading an expository passage and then had the students write a summary of the passage. This same process was repeated for both narrative and expository passages. These authors found significant differences between the narrative and expository think-aloud statements and summaries. Students reading narrative text had higher processing scores and included more important text propositions than students reading expository text.

Similar experiment by Cote, Goldman, and Saul (1998) examined expository text comprehension in fourth and sixth grade students. Results revealed that both fourth and sixth-grade students used strategies such as connecting to prior knowledge, paraphrasing, and metacognitive monitoring but that the students rarely attempted to make connections among propositions within the text itself. The summaries followed the text structure of the reading passages, but the easier passages prompted better summaries for both grade levels than the more difficult passages. In a second experiment, Cote, Goldman, and Saul (1998) used a similar design with a different group of fourth and sixth-grade students. In this experiment they removed the read-aloud and think-aloud components. The researchers found that rather than explain their summaries in terms of a distinct structure, the students tended to list surface-level facts, especially when attempting to summarize the more difficult expository passage.

2.4 Cognitive load theory: Limited working memory and unlimited long-term memory

The core assumptions of cognitive load theory are consistent with that of the information processing model. Typical of such assumptions are the limited working memory and the limitless long term memory which constitute the architecture of the cognitive load theory. Going back to Miller (1956) the working memory is assumed to be able to hold only seven chunks (items) of information. This means that mental work can be performed normally when processing loads do not exceed the limitations of the working memory. When processing loads exceeds the limit, intellectual work becomes limited. Even though cognitive load theory accepts limited capacity of the working memory in terms of duration and capability, this limitation applies to novel information (Bruning, Schraw, & Norby, 2011).When working memory is dealing with information already stored in the long term memory, the restrictions do not apply. The theory assumes an unlimited capacity for the long term memory (LTM), as well as the roles it plays in meaning-making and knowledge organization. Knowledge in the LTM is structured in to schemata (Anderson, 1978). Such schemata operates like a central executive that organizes information and knowledge in the form of a network leading to spread of activation and thus helping to process with ease information in the working memory. Under this circumstance in which schemata act as a central executive, working memory load can be largely decreased (Bruning, Schraw, & Norby, 2011). In this respect cognitive load theory assumes that when readers employ appropriate schemata, even highly complicated information can be managed as one element. Schema automation also enables learners to bypass the limited working memory through allowing cognitive processes to occur without conscious control.

2.5 Cognitive load and attention

Recent research has focused on the possible relationship between working memory capacity (WMC) and performance under load maintaining that the load is due to differences in the ability to allocate attention to maintain relevant information and suppress irrelevant distracters, with individuals high in WMC(HWMC) showing superior performance compared to individuals low in WMC (LWMC) (e.g., Engle & Kane, 2004). Engle (2002) suggested that HWMC and LWMC persons do not differ in the amount of attention resources (i.e.,

WMC) they have per se, but differ in terms of how well they can flexibly and efficiently allocate these resources, especially in times of interference or when demands on WMC are high. Similarly, Eysenck, Derakshan, Santos, and Calvo (2007) explained the finding that anxiety and performance are inversely related as a matter of individual differences in the ability to control attention, with HTA persons having an attention bias toward threat-related items (internally or externally generated).

2.6 Three different kinds of load in learning

Cognitive load theory assumes that three different kinds of cognitive load exist especially when learning is taking place: *extraneous load, intrinsic load*, and *germane load*.

***Extraneous load**:* this type of loadis instructional-oriented and is determined by instructional design and is influenced by the manner in which the material is presented or by the activities required of the learner. This type of load can be decreased or eliminated by using appropriate instructional design and suitable pedagogical methods (Sweller, van Merriënboer, & Paas, 1998).

Intrinsic load as opposed to extraneous load has to do with the degree of element interactivity that is the number of elements that have to be processed simultaneously (Sweller, 1994). Initially this type of load was not considered to be instructional-related because the load was thought to be intrinsic to the material being learned. Research has shown that intrinsic load can also be manipulated by altering the degree of element interactivity (Pollock, Chandler, & Sweller, 2002). However, element interactivity is also connected to individual‘s mastery level, namely, the number of interacting elements people deal with *at a particular level of expertise* (Van Merriënboer, & Sweller, 2005).

The implication here is that element interactivity cannot be measured merely by analyzing task or material. Some materials are not intelligible to some learners precisely because there are many interacting elements in the materials that have to be processed simultaneously, creating overload and causing high intrinsic load to the learners. However, since some learners are more experienced, they are likely to have parallel processing, that is, some learners are able to consider a large number of interacting elements as only a single element. Level of the learner’s expertise consequently determines what counts as an element. Therefore, intrinsic load cannot be determined without considering a learner‘s level of expertise (Schnotz & Kürschner, 2007).

Finally, ***germane cognitive load*** refers to the part of a learner‘s effort that is devoted to schema construction and schema automation, which are essential to learning. Sweller, van Merriënboer, and Paas (1998) argued that germane load should be increased as high as possible, but the increased germane load should stay within the limits of working memory. In order to do that, it is important to find appropriate instructional methods that can reduce extraneous load; reduced extraneous load enables learners to redirect their attention to cognitive processes relevant to schema construction and schema automation. Thus, the goal is to find instructional designs that decreases extraneous load and at the same time, increase a learner‘s effort and motivation. Such an increase is considered to enhance germane cognitive load resulting in schema construction and schema automation (Paas, Renkl, & Sweller, 2003). So Cognitive Load Theory (CLT) proposes that the total cognitive load is the sum of the three kinds of cognitive load: extraneous load, intrinsic load, and germane load. This sum should stay within limited working memory capacity because if the sum exceeds working memory‘s limited capacity, learning does not take place effectively (Sweller, 2005).

3. Research methodology

3.1 Sample

This study used the purposive experimental pre-test and post-test design from an estimated one hundred and twenty (120) third year Junior High School students between the ages of 11-15 randomly chosen from three

selected Junior High Schools within the Sunyani Municipality in the Brong Ahafo Region of Ghana. Forty students (40) assumed to be skilled and less skilled readers were purposively selected from each of the selected three (3) schools that is twenty (20) skilled and twenty (20) less skilled from each school. In a data no tabled here, an estimated 50% of the sample was male and the rest were females. The sample was purposively divided into two groups: experimental group and the control group, the former representing the skilled readers and the latter the non-skilled readers.

3.2 Materials and design

In all there were two (2) experiments that tested the two research questions. Experiment 1 was a pre-test on reading achievement specifically administered to test the over-all reading ability between the two groups: skilled readers and non-skilled readers through a proficiency test. Later The Passage Comprehension subtest of Woodcock Reading mastery Tests-Revised (WRMT–R; Woodcock, 1987), the comprehension component of the Gray Oral Reading Test—3 (GORT–3; Wiederholt & Bryant, 1992) also tested other high level comprehension other than word identification. In Experiment 2, the researcher sought to find out if the comprehension of expository text can be enhanced by removing from the reader some cognitive load imposed by other processes.

4. Experiment 1

This first experiment was pretesting phase. The purpose of this pretesting experiment was to assess the over-all reading comprehension of the participants to check whether or not those sampled as 'skilled readers' and 'less skill readers' in fact have any statistical difference between them in terms of reading comprehension as well as to test whether or not the comprehension of expository text required other mental processes than word identification.

4.1 Participants

One hundred and twenty (120) voluntary third year Junior High School participants (60 girls and 60 boys: 60 were perceived to be 'skilled readers' and the other 60 considered 'less skilled readers') were purposively selected from three (3) Junior High Schools (JHS) in the Sunyani Municipality in Ghana. All participants were between the ages of 11 and 15 and the sample consisted of seventy (70) children from working parents, thirty (30) from professional parents and twenty (20) from farming parents.

4.2 Materials

Two tests on reading achievement were administered to test to the over-all reading ability of the two groups-skilled and less skilled readers using Proficiency Test and Passage Comprehension subtest of Woodcock Reading mastery Tests-Revised ((WRMT–R; Woodcock,1987), the comprehension component of the Gray Oral Reading Test—3 (GORT–3; Wiederholt & Bryant,1992). The language proficiency test comprised some one hundred (100) multiple choice items covering many grammatical points

4.3 Procedure

The data collection procedure was conducted in two different sessions. In the first session, participants were asked to answer the proficiency test while in the second session they answered the six reading comprehension tests. Both tests had the same format that is they were expository passages followed by multiple choice questions.

4.4 Results

Table 1 shows that the skilled readers performed better on the proficiency test than the non-skilled readers. From the table, the skilled readers had a mean score of 84.02 with standard deviation of 9.420, while the

non-skilled readers had a mean score of 52.80 with standard deviation of 6.364. Their standard deviations however indicate that the scores of the skilled readers were more dispersed than that of the non-skilled readers. To find out if their mean scores were statistically significant, an independent samples t-test was run at an alpha level of 0.05 and the results as in table one shows that they were significantly different [t=-21.271, p=0.00].

Table 1

T-test on readers' proficiency test in Experiment 1

	Readers (N=120)	Mean	SD	t-value	p-value
Score for skilled and less skilled readers on Proficiency Test	Non-skilled Readers	52.80	6.364	-21.271	0.000
	Skilled Readers	84.02	9.420		

4.5 Discussion

The scores of the proficiency test above clearly indicate significant differences between skilled and non-skilled readers. The likely underlying explanation in the performances between the two groups suggest that for non-skilled readers many lower level processes in reading have still not been sufficiently automatized such as decoding, syntactic parsing. In decoding, readers crack the code of print in order to make print meaningful and there are two cognitive two processes involved, matching and recoding. In matching, readers match the printed word to a known pattern for the word and thus activating the word's meaning from the Long Term Memory. Recoding has to do with 'sounding out' and therefore printed word is translated into sound patterns and the sound patterns activate the word's meaning in the LTM. In the case of skilled readers, on the other hand, these lower level cognitive processes appear to be highly automatized and therefore unlike less skilled readers have sufficient cognitive resources allocated for higher level processes such as inference making as well as integrating textual information. Thus this finding suggests a probable link between those empirical studies that relate working memory capacity and performance load.

These studies make the submission that the ability to allocate attention to maintain relevant information and suppress irrelevant distracters, tends to be high with individuals high in WMC(HWMC) showing superior performance compared to individuals low in WMC (LWMC) (e.g. Engle & Kane, 2004). Again, this finding corroborates Engle (2002) position that HWMC and LWMC persons do not differ in the amount of attention resources (i.e., WMC) they have per se, but differ in terms of how well they can efficiently allocate these resources, especially in times of interference or when demands on WMC are high.

The results above showing that the mean scores were significantly different was also confirmed when we run an independent sample test at an alpha level of 0.05 at [t=-21.271, p=0.00]. Besides, as indicated, the results of the skilled readers were more dispersed compared to less skilled readers. These data were interpreted as confirming our first research question, namely, does the comprehension of expository text require other mental processes than word identification? Thus lower processes of word identification such as decoding and syntactic parsing appear to have occupied the attention of less skilled readers leaving insufficient resources for top-down comprehension processes for global integration of textual information.

This support the lexical quality hypothesis which states that reading skills of readers is more enhanced when readers' already have automatic knowledge of words, phonology, morphology and meaning. Once these automatic processes are automatic, these visual inputs are converted into linguistic representation. What is implied here is that reading comprehension has two processes: lexical access or word identification and this lexical access play a central role in linguistic comprehension (Perfetti & Harti, 2001). Whereas these lower skills appear to be automatic with skilled readers and thus facilitating reading comprehension, non-skilled readers allocate more resources to these such that higher processes of comprehension becomes impaired. These variations explain the differences in performance between skilled and less skilled readers which support the

interactive models of reading comprehension (e.g. Kintsch, 1998; Just & Carpenter, 1987).

5. Experiment 2

The purpose for this experiment was to test whether the comprehension of expository can be enhanced by removing from the reader some cognitive load imposed by other processes than word identification. I examined WMC of both skilled readers and low skilled readers and load type. My hypothesis in this experiment is that less skilled readers assumed to have Lower Working Memory Capacity (LWMC) and skilled readers perceived to possess Higher Working Memory Capacity (HWMC) would perform similarly under no load. However when loaded, less skilled readers would perform poorly compared to skilled readers. I also make the hypothesis that other mental higher process such as inferential comprehension and comprehension monitoring would act as intrinsic load that would adversely affect reading comprehension of less skilled readers with LWMC compared to skilled readers with HWMC.

5.1 Participants

The same sample size as in experiment 1 from the same selected Junior High Schools from the same study area and the same age group was used in this second experiment. The sample consisted of seventy (70) children from working parents, thirty (30) from professional parents and twenty (20) from farming parents. Half of this population was considered skilled readers and the other half was perceived as non-skill readers.

5.2 Materials and procedure

Ninety multiple choice questions adapted from the comprehension portion of the Gates-MacGinitie reading test (GMRT) grade level 7-9 was used as the instrument to collect data. Question items were categorized according to the following three codes: a) *item difficulty as function of information abstractness*: This score focused on whether or not information requested by the question was abstract or concrete. Abstractness was categorized using a Likert's-type five-point scale: *most concrete,* were questions that were asked to identify persons, animals or things. *Most abstract* class, the questions that asked for the 'identification of equivalence, difference, or theme; b) The second coding was *item difficulty as function of degree of inf*erence necessary to answer the question asked. Here readers had to weigh the degree of overlap between question and target answer and the passage. Four tasks were required of readers: i) *text-based questions*- these were questions that could be found in a text for example in a single sentence, ii) *reworded questions*: this was similar to text-based except that synonyms were used instead of the exact word from the text and iii) *inference-making*: these were questions in which correct answers were not directly asked but could be inferred and iv) *integration* questions were those that required the amalgamation of multiple sentence meanings from the passage in order to be able to answer the question.

5.3 Results

Readers' scores on item difficulty as function of abstractness were measured on the following five variables: *'most concrete', 'highly concrete', 'highly abstract', 'intermediate'* and *'most abstract'*. The skilled readers outperformed the non-skilled readers on all the five variables. And the independent samples t-tests at 0.05 significant levels also indicated that there were statistically significant differences in the mean scores of the non-skilled and skilled readers on all the five variables. For example, on the variable *"most abstract"* the non-skilled readers had a mean of 32.53 and standard deviation of 8.829, the skilled readers had a mean of 56.93 and standard deviation of 21.672. The standard deviation of the two groups indicates that the scores of the skilled readers were more spread than that of the non-skilled readers. The comparison of these means with the t-test gave a t-value of -8.076, p-value of 0.000 indicating a significant difference in these mean scores.

Table 2

Item difficulty as function of information abstractness

	Readers (N=120)	Mean	SD	t-value	p-value
Most Concrete	Non-skilled Readers	44.92	11.833		
				-13.211	0.000
	Skilled readers	82.12	18.323		
Highly Concrete	Non-skilled Readers	40.72	8.032		
				-18.319	0.000
	Skilled readers	74.90	12.017		
Highly Abstract	Non-skilled Readers	34.32	9.464		
				-31.039	0.000
	Skilled readers	75.47	3.985		
Intermediate	Non-skilled Readers	28.95	9.077		
				-26.626	0.000
	Skilled readers	66.78	6.225		
Most Abstract	Non-skilled Readers	32.53	8.829		
				-8.076	0.000
	Skilled readers	56.93	21.672		

Table 3

Item difficulty as function of degree of inference necessary to answer questions

	Readers	Mean	SD	t-value	p-value
Text-based	Non-skilled Readers	51.83	4.581		
				-19.751	0.000
	Skilled readers	75.53	8.087		
Rewording	Non-skilled Readers	44.27	5.544		
				-31.301	0.000
	Skilled readers	77.43	6.052		
Inference	Non-skilled Readers	31.52	3.352		
				-56.065	0.000
	Skilled readers	69.78	4.088		
Bridging	Non-skilled Readers	26.47	4.188		
				-56.149	0.000
	Skilled readers	64.68	3.202		

On the measure of degree of inference tested across four variables namely, '*text-based', 'rewording', 'inference'* and '*bridging',* it is again evident that the less skilled readers did perform far below that of the skilled readers as can be seen from Table 3 above. For example, even on the least measure of '*text-based'*, that is questions that could be found directly in the text as for example in a sentence in which one would have expected to find no difference, non-skilled readers score a mean of 51.83 with a standard deviation of 4.581, compared to skilled readers mean score of 75.53 and 8.087 (SD). The independent samples t-tests at 0.05 significant levels also indicated statistically significant differences in the mean scores of the non-skilled and skilled readers on all the four variables. Thus as one moves through the least difficulty level towards the highly difficult variables, the differences between the two groups become greater. The standard deviation of the two groups indicates that the scores of the skilled readers were more spread than that of the non-skilled readers. The comparison of these means with the t-test gave a t-value of -56.149, p-value of 0.000 indicating a significant difference in these mean scores.

5.4 Discussion

The scores of the two groups when tested along the two variables of item difficulty as function of information abstractness and as function of degree of inference along the different levels suggest the effect of mental load and working memory capacity. For example, one can see that the highest mean scores for skilled readers and non-skilled readers on item difficulty measured on *'most concrete'* as in Table 1 were 82.12 (SD

18.323) and 44.92 (SD 11.833) with t-value at -13.211. In the second variable on inference as in Table 2, we have a similar pattern in the least difficult item of '*text base':* the highest mean scores were on the least difficult item: the highest mean scores for both skilled readers and non-skilled readers were 75.53 (SD 8.087) and 51.83 (SD 4.087) with t-value of -19.751. When one compares these scores with the most difficult items as indicated in both Tables 2 and 3 of the second experiment across the different levels, there appears to be a consistent picture: the more difficult and more cumbersome the item in the expository text, the less the performance of the less skilled readers and the wider the performances.

Again, this consistent pattern across the different variable and the different t-levels were interpreted as giving some plausibility to our second research question: Can the comprehension of text be enhanced by removing from the reader some cognitive load imposed by other processes than word identification? The fact that non-skilled readers performance continued to go down the more the item difficulty was increased suggest the following: a) lexical access of word identification was a load for non-skilled readers, b) since lexical access was a load, other comprehension process was impaired for less skilled readers, c) these were not so much the case with skilled readers since lexical access appeared not to have been a problem, d) these elementary constraints even at the lower level in comprehension was assumed to be the possible cause of the poor performance of the less skilled readers. On the basis of these empirical data, this researcher interpreted this result as giving some plausible answer to the second research question, namely, that comprehension is likely to be enhanced even for less skilled readers when some cognitive load is removed.

6. General discussion

The major finding that that can be gathered from the data in these two experiments is that lexical access or the ability to decode does not automatically transfer to comprehension ability (Woolley, 2010; Pressley & Gaskins, 2006). Even though good comprehenders must necessarily be initial good decoders, the ability to identify words per se is not enough for good comprehension. The ability of skilled readers to combine both simple tasks such as 'most concrete' and 'text-based' with higher level comprehension processes such as 'most abstract, ''inference' as indicated in this study is consistent with the claim that reading comprehension is both greater accumulation of knowledge of words as well as simultaneously making and constructing meaning out of these words from one's Long Term Memory (cf. McNamara, Ozuru, & Floyd, 2011).

Most skilled readers generally tend to be more strategic and appear to apply self-regulated strategies. Besides, unlike poor readers, skilled readers when reading this expository text as was particularly noticeable in this study were quick to recognize underlying text patterns such as comparison and causation and they used such text structure as schema to help them remember and understand information in the text and were able to answer correctly most of the questions asked. This finding besides suggesting some consistency with other research work such as (Chambliss, 1995; Meyer, Brandt, & Bluth, 1980), also confirms the unlimited capacity theory of the Long Term Memory and its roles in meaning-making and organization as schemata (Anderson, 1978). Under this circumstance in which the LTM acts as schemata and a central executive in which information is organized as interrelated network leading to a spread of activation, working memory load can be largely decreased (Bruning, Schraw, & Norby, 2011). This process appears to be typical with the proficient readers in this study, compared to the less proficient as the tests on item difficulty moves from one level to the other. It appears that in the more difficult tests, proficient readers had sufficient WMC resources that helped them to engage with the text at the level of higher mental process such as inference-making and integrating textual information. Thus, when reading difficult text such as expository text, highly complicated information was managed as one element through automation. In so doing, readers bypass the limited working memory making it possible for cognitive process to occur without conscious effort. This automatization process was ostensibly absent in non-proficient readers in this study. This corroborates the work of Sweller, van Merriënboer, and Paas (1998).

7. Implications for teaching to enhance coherent text base for less skilled readers

The findings of this study is consistent with a massive number of other research studies, suggesting that the number one underlying factor implicated in less skilled readers is deficiency in meta phonological awareness. This deficit implies that for many less skilled readers, many lower level processes such as lexical access is not sufficiently automatized. This absence of automaticity of lower level processes sets limits to their higher level processes in text comprehension because they tend to spend more time at lower level process, such that insufficient resources are allocated for higher mental processes of inference, bridging, integrating textual information, etc. What this means is that the most striking characteristics of poor readers is that of verbal memory problems. As indicated in the results of this study, the consistent poor scores of less skilled readers compared to the skilled readers were their inability to recall what they had read. This is in line with those studies reporting a relationship between reading disability and working memory capacities.

From this analysis, it implies that attention and mind wandering controls continue to mediate WMC's relation to reading comprehension. Besides, since the executive-attention view of WMC posits the control of attention as one important mechanism underlying performance on both WMC tasks and reading comprehension, and thus of their covariation (Engle & Kane, 2004), it is important to base teaching strategy on how to control attention deficit. Based on the above findings of this paper, this study suggests the following WMC-related interventions to improve reading of less skilled readers:

7.1 Hierarchical summary training

One cannot ignore the individual differences in executive functions of the Long Term Memory especially the ability for proficient readers in this study to organize knowledge as interrelated network leading to a spread of activation and by so doing decreasing working memory load (Bruning, Schraw, & Norby, 2011). What is implied here is that in teaching poor readers to enhance reading, teachers need to emphasize hierarchical summary training. Research reports increasingly show that even rhetorical organization of both narrative and expository text is more likely to interact with both native and non-native readers of English to affect reading and that explicit teaching of various aspects of text structure can facilitate first language reading (Carrel, 1985). When poor readers are trained in making summaries, it is also thought that they are trained to develop schemata organized in hierarchies similar to outlines with specific information grouped under general categories which are still grouped under more general categories. In this hierarchy one moves from general to specific and the concepts well anchored in the schema. So any new information relating to the schema is learned more readily than would information not relating to the schema. This hierarchical summary training is more likely to reduce the insufficient resources in the WMC typical of poor readers.

7.2 Conceptual networking and conceptual mapping

Concept mapping is a technique for representing knowledge in graphs. Knowledge graphs are networks of concepts. Networks consist of nodes (points/vertices) and links (arcs/edges). Nodes represent concepts and links represent the relations between concepts. Concepts and sometimes links are labeled. Links can be non-, uni- or bi-directional. Concepts and links may be categorized; they can be simply associative, specified or divided in categories such as causal or temporal relations. Concept mapping can be done for several purposes: to generate ideas (brain storming, etc.); to design a complex structure (long texts, hypermedia, large web sites, etc.); to communicate complex ideas; to aid learning by explicitly integrating new and old knowledge; to assess understanding or diagnose misunderstanding.

This concept of networking and conceptual mapping is linked to the theory of spread of activation proposed in Anderson's Adaptive Control of Thought Theory (ACT). Anderson's ACT theory of factual memory, retention and recall states that information is encoded in all or none manner into cognitive units. The storage of this units increases with practice and decay and essential to this is the retrieval process. In the framework of this theory,

cognitive units form an interconnected network and that this retrieval is performed by spread of activation through a network, so the level of activation in network determines the rate and probability of recall (Anderson & Pirolli 1984). Since recall of reading materials appears to be one of the striking differences between less skilled and skilled readers due to low WMC and insufficient resources for global processing, it is important that teaching enhances children's networking and mapping capabilities.

The underlying principle of the spread of activation and conceptual networking has to do with associative retrieval. The idea behind this form of information retrieval is that it is possible to retrieve relevant information by retrieving information that is "associated" with some information the user already retrieved and that is known it to be relevant. The associations between information can either be static and already existing at the time of the query session or dynamic and determined at run time. So associations among information items (document or parts of documents, extracted terms, index terms, concepts, and many others) are created before the query session, and they make use of semantic relationships between these items to recall information in chunks. By so doing cognitive load is reduced.

7.3 Graphic aids and flow charts

Since most less proficient readers have attention deficits due to LWMC (low working memory capacity), the use of Graphic Aids an flow charts help children to compare information and make connections between verbal and nonverbal codes as well as connections between the two. There is a massive empirical research that supports the use of graphic aids/graphic organizers for improving student literacy learning in the basic schools especially reading. For example, in cognitive theory of learning, the dual code theory maintains that we code information in both verbal and nonverbal formats. By attending to both formats through graphic organizer information becomes easier to retain and to recall. Besides, as explained above, human memory exist as schemas or network. Using graphic organizer can help students to link existing knowledge organized in schema to the new knowledge. In short, the use of graphic organizers in teaching reading will enhance students who have low WMC-related problems reading ability. Thus if graphic organizers and flow charts are used properly in teaching, they can help reduce the cognitive load in reading and consequently, enable more resources (working memory) to be devoted to higher mental processes in comprehension such as inference-making and bridging.

8. Conclusion

The findings of this study show a consistent pattern of differences between skilled and less skilled readers: the more difficult the task given to the two groups, the wider the differences across the different variables that students were tested. This was interpreted as cognitive load effect; whereas some tasks may facilitate a particular type of text, others may not be that effective especially for less proficient readers who have English as second language. These less proficient readers were more preoccupied with lower-order processing of decoding and syntactic parsing. Unlike skilled readers whose lower-level processes are well automated, these poor readers allocated more attention to these lower processes and consequently attention allocation to global text features was impaired. So three (3) fundamental points could be deduced from this study: a) for non-skilled readers, many lower level processes are not sufficiently automatized; b) therefore sufficient cognitive resources cannot be allocated to higher-level processing; c) this means that for less skilled readers, unlike skilled readers' insufficient resources especially in terms of attention undermined inference-making and textual integration.

Readers' attention and working memory are likely to develop as they grow. This notwithstanding, the capability to use higher-level process in reading is not automatic without instructional support. Younger children especially in the elementary grades whose native language is not English are not likely to intuitively know how to use requisite strategies such as schema induction, spread of activation, metacognitive strategies etc. that would help reduce cognitive load. These strategies need to be taught through instructional interventions such as hierarchical summary training, conceptual networking and conceptual mapping, graphic aids and flow charts.

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