

# Split- Attention in Reading Comprehension: A Case of English as a Foreign/ Second Language

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*Abstract--- Recent research on the role, the development, and the effectiveness of reading comprehension instructions has provided substantial results concerning the methodology of teaching English as a second / foreign language (ESL/EFL). Cognitive load theory has assisted researchers to recognize cognitive effects in reading comprehension that can lead to improvements in reading skill. The aim of this paper is to analyse the split-attention effect in reading comprehension instructions to assist teachers of English to facilitate learning. The experiment was designed to investigate whether the split attention effect applied to reading comprehension in EFL/ESL by comparing two instructional formats: split-attention and integrated formats. Participants were randomly allocated to one of the two groups and received one of the two instructional formats. The integrated format included a reading text and 10 questions integrating physically into the text. The split-attention format consisted of the same reading text and the same questions at the end of the text. Results indicated that the split attention format increased extraneous cognitive load and interfered with the reading comprehension process compared to the integrated format.*

*Keywords---Cognitive load theory, reading comprehension, split attention effect*

## I. INTRODUCTION

Learning English as a foreign/ second language (EFL/ESL) is important in all universities in Vietnam. However, reading tasks in currently available course books use conventional formats. These formats are not very effective in helping students to improve their reading skills. One solution is to apply cognitive load theory in designing reading tasks. The theory is becoming popular as an application for teaching and learning and could help instructors to provide suitable task formats in EFL/ESL teaching and learning.

### *Cognitive Load Theory*

Cognitive load theory (Chandler & Sweller, 1996) proposes that conventional instructional procedures are insufficient because they require learners to engage in unnecessary cognitive activities that cause a heavy working memory load. Working memory is associated with consciousness and it relates to the way people direct their own attention to think or to process information. Miller (1956) indicates that the biggest limitation of working memory is the capacity to deal with no more than about seven elements of information simultaneously (Miller, 1956). Humans are aware of working

memory and can supervise its contents (Sweller, 2004). People use working memory for processing information by organizing, contrasting and comparing elements, so they can manage only two or three items of information at the same time (Sweller, 2004). Too many elements may strain the working memory and reduce the effectiveness of processing (Kalyuga, Chandler, Sweller, 1999). Thus, working memory is considered as the memory system having the role of holding and manipulating information. In reading comprehension, working memory is limited, so if unnecessary items of information are required to process reading material it may strain working memory and decrease learning (Sweller, 1999; Sweller, Chandler, 1994).

In contrast, long term memory is unlimited (Sweller, Chandler, 1994). Long-term memory refers to our immense body of knowledge and skills. For instance, in reading comprehension, vocabulary, structures, and everything people know are kept in long-term memory. Long-term memory has no known limits in its capacity to store information in a relatively permanent form and no one is directly aware of their long-term memory until some of its contents and functioning are brought into working memory (Kirschner, 2002). Sweller (2004) indicates that while long-term memory is a passive information store, it is a critical component of all cognitive activities.

Obviously, researchers have paid attention to the cognitive and instructional processes that occur when two separate source of information are presented that must be mentally integrated, referred to as the split-attention effect (Yeung, Jin, Sweller, 1997). Cognitive load theory calls the unnecessary memory load caused by the split attention effect extraneous load (Sweller, 1999). To overcome a split-attention effect, a physically integrated format is a good way to decrease extraneous load and to increase effectiveness of instructions (Sweller, 1999)..

With regards to the split-attention effect in reading comprehension, Leahy & Sweller (2004) noted that learners needed to “split” attention and mentally integrated multiple sources of information in a text for understanding to occur. For example, they are two or more related sources of information (e.g., text and diagram), the instruction may require learners to integrate corresponding (verbal and pictorial) information to construct a relevant schema and achieve understanding. The process of information integration may place an unnecessary strain on limited working memory (Kalyuga, Chandler, & Sweller, 1999). Yeung (1996) examines the split attention effect in reading with explanatory notes. In the integrated format, the reader refers directly to the meaning of possibly new words, thus the cognitive load should be lower (Yeung, 1996).

In reading comprehension, questions are often used to check readers’ comprehension (Cainey, 1990). Questions are essential instruments for the enhancing of reading comprehension (Cainey, 1990; Kruidenier, 2002).

Fincke (1968) shows that locating questions before a text may have not consistently facilitated comprehension. However, reference Cainey (1990) demonstrates that appropriate post questions enhance comprehension effectively. Cainey (1990) stresses the usefulness of questions depending upon the kind of questions, the time of questions, the text type, how the question is asked and the teacher’s reason why the question is asked. The cognitive load

theory may be used to explain the process of enhancing reading comprehension by using an appropriate location of questions. It can be hypothesized that the positioning of questions at the end of a text could make it difficult for readers because their attention may be divided between the text and the questions. In other words, the split-attention effect may increase extraneous cognitive load in reading comprehension and the effect may influence the learning process of readers.

The following experiment aimed to investigate the differences between a split attention and integrated format in reading instruction. The split attention format included the reading text with questions about the text placed at the end of the text. The integrated format also had the reading text, but the same questions as used in the split attention format were integrated physically into relevant paragraphs of the text.

## II. THE EXPERIMENT

### *Participants, Method, and Materials*

21 Vietnamese students studying English as a foreign/ second language (EFL/ESL) at the Hochiminh City University of Social Sciences and Humanities (Vietnam) participated in this study. Students had studied English for 7 years (from the 6<sup>th</sup> grade class until the 12<sup>th</sup>). They were 2<sup>nd</sup> year students in the Centre for Foreign Languages. At the Centre, students learn English as a major in order to get a Bachelor of Arts in English. Students participated in this experiment as a regular class activity. For the purposes of this study, they were randomly allocated to two groups (11 participants for the split attention group and 10 for the integrated one).

The materials consisted of a text titled “The early Aborigines” that was extracted from the reference (Anderson, Durston, & Poole, 1969) (527 words, see Appendix A1, A2 and B below). There were two phases: the learning phase and the test phase. There were 10 questions used to aid comprehension of the text in the learning phase and 12 questions in the test phase (see Appendix B). Four of the text questions were identical to four of the learning phase questions. Participants were randomly allocated to one of the two groups and receive one of two instructional formats: integrated or split attention formats. For the integrated format the reading text and the 10 questions were integrated physically. For the split attention format the reading text came first and the questions appeared at the end of the text. The procedures for the two conditions were identical. The design was applied in class with the two groups given learning questions to assist them to comprehend the text.

## III. PROCEDURE

In the learning phase, participants were asked to read the material and answer the questions in 10 minutes (1 minute per question). After they had answered their learning questions, learners were given the test questions. They could use the passage alone (stripped of the learning questions) while attempting to answer the test questions. The original learning questions were not visible in the test phase. There were 12 test questions,

4 of which were identical to 4 questions presented during the learning phase. The duration of the test phase was 18 minutes (1.5 minutes per question). Students' answers to the questions were written on an answer sheet given to participants.

For both phases, right answers were given a score of '1' and wrong answers were given a score of "0". The maximum total score was 10 in the learning phase and 12 in the test phase. The data were analyzed by SPSS (Statistical Package for the Social Sciences) to determine whether there was a significant difference between the two groups in the scores obtained from the learning and test phases.

#### IV. RESULTS

Firstly, test scores were analyzed by a 2 (instructional groups: split attention and integrated groups)  $\times$  2 (2 phases: learning and test phases) ANOVA with repeated measures to address the effect of two groups in two phases on EFL/ESL learner's reading comprehension. The 0.05 significance level was used in this analysis. Table 1 shows the mean scores and standard deviations for the test scores of the two groups in the two phases.

TABLE I  
MEAN SCORES AND STANDARD DEVIATIONS FOR BOTH GROUPS IN BOTH PHASE IN THE EXPERIMENT

	GROUP	Mean	Std. Deviation	N
Learning scores	Split attention group	.127	.224	11
	Integrated group	.300	.205	10
	Total	.209	.227	21
Test scores	Split attention group	.303	.387	11
	Integrated group	.566	.296	10
	Total	.428	.364	21

There was a significant effect between the two instructional groups  $F(1, 19) = 4.630$ ,  $MSE = .108$ ,  $p = .044$ , partial  $\eta^2 = .196$ . Also, there was a significant effect for the two phases,  $F(1, 19) = 8.634$ ,  $MSE = .059$ ,  $p = .008$ , partial  $\eta^2 = .312$  with higher means for the test phase. There was no significant interaction between the two groups and the two phases,  $F(1, 19) = .365$ ,  $MSE = .059$ ,  $p = .553$ .

These results indicated that using questions integrated physically in the text was more effective than the split attention format. The overall results showed a significant difference between the two groups,  $F(1, 19) = 4.630$ ,  $MSE = .108$ ,  $p = .044$ . This experiment also showed that the split-attention effect was generated by the split-attention format instruction in reading comprehension. The effect depended on the different reading instructions. In this case, there were two distinct formats: split attention and integrated formats. The integrated format demonstrated its superiority in the two phases with higher mean scores than those of the split attention format (.300 > .127 in the learning phase; .566 > .303 in the test phase).

From this experiment, we can conclude that the split attention format imposed an extraneous cognitive load that interfered with learning and the integrated format may decrease the extraneous cognitive load.

## V. DISCUSSION

At the start of this study it was hypothesized that the group of students who used the integrated format would obtain higher test scores than the group who used the split-attention format in both the learning and test phases. The hypothesis was tested by comparing the two instructional groups in both phases. Results supported the hypothesis in that a split attention effect occur between the two groups and two phases.

In the learning phase, the integrated format reduced the extraneous cognitive load and helped students spend less time answering questions. In the split attention format, students may have spent much more time reading and re-reading the whole text before finding answers to the questions at the end of the text. For difficult questions, students may have had to re-read the text several times to find an answer. Because the answer was more readily found in the integrated group, such reading may not have been necessary. Hence, students in the split attention group required more time than those in integrated group. In other words, the split attention format increased extraneous cognitive load as students searched keywords for answers and re-read the text.

In the test phase, the integrated group performed better than the split attention group because in this phase, students in the integrated group had constructed more suitable information (schemas) by having answered the learning questions. They recalled the previous information quickly and it was easy for them to find answers to the test questions in the test phase. Furthermore, the additional paragraphs (stripped of learning questions) may have helped them to find more schemas to answer text questions. In other words, the previous information students accessed in the learning phase may have helped them find answers to questions in the test phase. On the contrary, students in the split attention group found it more difficult to find the information they needed in order to answer the questions, as they may not have previous information from the learning phase due to cognitive overload. The above results are consistent with the view that extraneous cognitive load is harmful to learning high cognitive load materials (Chandler & Sweller, 1996; Adams & Collins, 1979). The results from the study suggest that the use of integrated questions may be very useful in improving comprehension, especially, in an EFL/ESL context.

The findings of this study have important implications for reading instructional design. In some EFL reading texts, where mental integration between questions and text is crucial in order to make sense of the material, the integrated instructional format should replace the conventional format. The present research focused on the split-attention effect in EFL/ESL reading comprehension. However, other cognitive effects may be further explored in order to enhance the process of EFL/ESL reading comprehension. The split attention effect may occur when reading instruction includes questions at the end of a text. Alternatively, the questions may be presented as auditory (spoken) rather than as visual (written) text (Kalyuga, 2003) in order to test for the modality effect. The redundancy effect may occur

when learners are presented information or required to engage in activities that are irrelevant to schema acquisition and automation (Sweller & Chandler, 1994). In the current context, the redundancy effect may occur when readers may comprehend the text better without questions because they are redundant. It occurs because inappropriate questions may cause an extraneous cognitive load. An experiment testing for the redundancy effect in EFL/ESL reading comprehension would consist of a reading text and questions for one group with another group presented the same text without questions. Superior performance by the text alone group would provide an example of the redundancy effect.

## VI. CONCLUSION

The study suggests that extraneous cognitive load can be reduced by using an integrated format in reading comprehension tasks, because providing a split-attention format imposes a heavy extraneous cognitive load that interferes with comprehension. In other words, integrated format assists learners to construct the necessary relevant schemas in reading comprehension and to facilitate the reading process. For EFL/ESL learners, the split attention format is a barrier to comprehending texts. To improve learners' reading comprehension, it may be necessary to replace split attention instructions with integrated ones.

## APPENDIX A1

### *The Split Attention Format – The Learning Phase*

#### ***Read the text and answer the following questions***

#### THE EARLY ABORIGINES

Science has not yet established precisely when, how, from when and why the first humans came to Australia. Their origin remains an unsolved mystery. Skulls of primitive people have been found in various parts of Australia, in conditions, which have suggested that their ages could date back from 12,000 to 125,000 years.

Blood group tests, physical descriptions and measurements, and the study of aboriginal customs, beliefs, art, tools and weapons, have made it clear that, before the arrival of Europeans, the Australian aborigines were of two distinct races, identified somewhat loosely as “Tasmanians” and “Mainlanders”.

The Tasmanians were small people, with wooly hair and black skins. It may be assumed that they were isolated in Tasmania when it was cut off from the Mainland by the geologic subsidence, which formed Bass Straits, thousands of years ago. On this theory they may have entered Australia from the North, possibly by a “land- bridge” from Papua, and were driven further and further to the South by later immigrants until a few families reached Tasmania, when it was a peninsula, and were later isolated there.

On this hypothesis, the mainlanders and with wavy, not wooly hair, and a brown rather than ebony black skin-may have migrated to Australia from islands of the Arafura Sea; but there are doubts as to this theory, since the Mainlanders, like the Tasmanians, had no knowledge of seagoing vessels; they had only frail craft in which they navigated streams and calm coastal waters.

The theory of a land-bridge between Australia and Asia within “recent” times, up to one million years ago, conflicts with geological evidence that Australia became separated from Asia 125 million years ago. It is assumed by some that if indeed the aborigines did migrate south to Australia, then they brought the dingo with them; but fossil remains of the dingo have been found in association with marsupial fossils of very great antiquity. Even this, however, may have been coincidental and no convincing conclusion can be drawn from it.

Notwithstanding these diversities of opinion, the Australian Mainland aborigines are undoubtedly a distinct race of mankind. The “Carpentarian” aborigines in northern regions are darker in skin color than those of the south, the “Murrayians”-but this may be an effect of sunburn, rather than of genetic causes. The aborigines were Stone Age people, having no knowledge of the use of metals. They were skillful as hunters and trackers, and were careful never to deplete the sources of their food supply beyond natural replenishment. They did not cultivate the soil, but lived on Nature’s bounty, which was more than adequate for their food needs. Their invention of the boomerang and the woomera (spear-thrower) showed high ability, but they did not use the bow and arrow, which were known to the natives of Indonesia and New Guinea. They migrated from the islands to the North of Australia they must have done so before the bow and arrow were known there.

When Europeans arrived, there were possibly 300 “nations” of aborigines in Australia, each with its own territorial boundaries, and speaking its own language. The impact of Europeans destroyed their tribal and social structures throughout the 19<sup>th</sup> century.

### Comprehension Check

1. *When did the first people reach Australia?*

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2. *What evidence is there for two distinct races as “Tasmanians” and “Mainlanders”?*

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3. *Did the “Tasmanians” aborigines reach Australia before, after or at the same time as the “Mainland” aborigines?*

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4. *Where is it hypothesized that mainlanders migrated from?*

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5. *Why are there doubts concerning this hypothesis?*

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6. *List ways the Mainlanders differed from Tasmanians.*

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7. *What evidence is there that dingoes came to Australia a very long time?*

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8. *Why are the “Carpentarian” aborigines in northern regions darker in skin color than those of the south, the “Murrayians”?*

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9. *What evidence is there for the skillfulness and ability of the Australian aborigine?*

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10. *How many languages did aborigines speak when Europeans arrived?*

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## **APPENDIX A2**

### *The Integrated Format- The Learning Phase*

***Read the text and answer the following questions:***

#### THE EARLY ABORIGINES

Science has not yet established precisely when, how, from when, and why the first humans came to Australia. Their origin remains an unsolved mystery. Skulls of primitive people have been found in various parts of Australia, in conditions, which have suggested that their ages could date back from 12,000 to 125,000 years.

1. *When did the first people reach Australia?*

---

Blood group tests, physical descriptions and measurements, and the study of aboriginal customs, beliefs, art, tools and weapons, have made it clear that, before the arrival of Europeans, the Australian aborigines were of two distinct races, identified somewhat loosely as “Tasmanians” and “Mainlanders”.

2. *What evidence is there for two distinct races as “Tasmanians” and “Mainlanders”?*

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The Tasmanians were small people, with wooly hair and black skins. It may be assumed that they were isolated in Tasmania when it was cut off from the Mainland by the geologic subsidence, which formed Bass Straits, thousands of years ago. On this theory they may have entered Australia from the North, possibly by a “land- bridge” from Papua, and were driven further and further to the South by later immigrants until a few families reached Tasmania, when it was a peninsula, and were later isolated there.

*3. Did the “Tasmanian” aborigines reach Australia before, after or at the same time as the “Mainland” aborigines?*

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On this hypothesis, the mainlanders with wavy, not wooly hair, and a brown rather than ebony black skin-may have migrated to Australia from islands of the Arafura Sea; but there are doubts as to this theory, since the Mainlanders, like the Tasmanians, had no knowledge of seagoing vessels; they had only frail craft in which they navigated streams and calm coastal waters.

*4. Where is it hypothesized that mainlanders migrated from?*

---

*5. Why are there doubts concerning this hypothesis?*

---

*6. List ways the Mainlanders differed from the Tasmanians?*

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The theory of a land-bridge between Australia and Asia within “recent” times, up to one million years ago, conflicts with geological evidence that Australia became separated from Asia 125 million years ago. It is assumed by some that if indeed the aborigines did migrate south to Australia, then they brought the dingo with them; but fossil remains of the dingo have been found in association with marsupial fossils of very great antiquity. Even this, however, may have been coincidental and no convincing conclusion can be drawn from it.

*7. What is evidence is there that dingoes came to Australia a very long time ago?*

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Notwithstanding these diversities of opinion, the Australian Mainland aborigines are undoubtedly a distinct race of mankind. The “Carpentarian” aborigines in northern regions are darker in skin color than those of the south, the “Murrayians”-but this may be an effect of sunburn, rather than of genetic causes. The aborigines were Stone Age people, having no knowledge of the use of metals. They were skillful as hunters and trackers, and were

careful never to deplete the sources of their food supply beyond natural replenishment. They did not cultivate the soil, but lived on Nature's bounty, which was more than adequate for their food needs. Their invention of the boomerang and the woomera (spear-thrower) showed high ability, but they did not use the bow and arrow, which were known to the natives of Indonesia and New Guinea. They migrated from the islands to the North of Australia they must have done so before the bow and arrow were known there.

8. *Why are the "Carpentarian" aborigines in northern regions darker in skin color than those of the south, the "Murrayians"?*

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9. *What evidence is there for the skillfulness and ability of the Australian aborigines?*

---

When Europeans arrived, there were possibly 300 "nations" of aborigines in Australia, each with its own territorial boundaries, and speaking its own language. The impact of Europeans destroyed their tribal and social structures throughout the 19<sup>th</sup> century.

10. *How many languages did aborigines speak when Europeans arrived?*

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## APPENDIX B

### THE TEST PHASE

Answer the following questions:

1. When did the first people reach Australia?

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2. Describe the physical characteristics of the Tasmanians.

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3. Why was Tasmania cut off from the Mainland thousands of years ago?

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4. Describe the physical characteristics of Mainlanders.

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5. Where is it hypothesized that mainlanders migrated from?

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6. Why are there doubts concerning this hypothesis?

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7. List ways the Mainlanders differed from the Tasmanians?

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8. When did Australia become separated from Asia?

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9. Did the aborigines have knowledge of the use of metals?

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10. How did the aborigines obtain food?

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11. About how many nations of aborigines were there in Australia when Europeans arrived?

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12. When were the aborigines' tribal and social structures destroyed?

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#### REFERENCES

- Adams, M.J., & A. Collins. (1979) A schema-theoretic view of reading. In Roy O. Freedle (Ed.) *New directions in discourse processing* (pp. 1-22). Norwood, N.J.: Ablex.
- Anderson, A., Durston, H.B., & Poole, M.E. (1969). *Efficient reading: A practical guide*. McGraw-Hill Book Company.
- Cairney, T.H. (1990). *Teaching reading comprehension*. USA: Open University Press.
- Chandler, P., & Sweller, J. (1996). Cognitive load while learning to use a computer program. *Applied Cognitive Psychology, 10*, 151-170
- Fincke, W. (1968). The effect of asking questions to develop purposes for reading on the attainment of higher level of comprehension in a population of third grade children (Doctoral dissertation, Temple University, 1968). *Dissertation Abstract International, 1968, 29/06A, 1778*
- Kalyuga, S. (2003). The expertise reversal effect. *Educational Psychologist, 38*, 23-31.
- Kalyuga, S., Ayrea, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*, 23-31.
- Kalyuga, S., Chandler, P., & Sweller, J. (1999). Managing split attention and redundancy in multimedia instruction. *Applied Cognitive Psychology, 13*, 351-371.
- Kirschner, P.A., (2002). Cognitive load theory: implications of cognitive load theory on the design of learning. *Learning and instruction, 12*, 1-20.

- Kruidenier, J. (2002). Research-based principles for adult basic education reading instruction. Washington, DC: National Institutes for Literacy, Retrieved August 4, 2006, from [www.nifl.gov/partnershipforreading/publication/html/adult\\_ed/index.html](http://www.nifl.gov/partnershipforreading/publication/html/adult_ed/index.html)
- Leahy, W., & Sweller, J. (2004). Cognitive load and the Imagination effect. *Applied Cognitive Psychology*, 18, 857-875.
- Miller, G.A. (1956). The magical number seven plus or minus two: Some limitations on our capacity for processing information. *Psychological review*, 63, 81-97.
- Sweller, J. (1999). *Intructional design in technical areas*. Camberwell, Vic: The Australian Council for Educational Research LTD.
- Sweller, J. (2004). Intructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Intructional science*, 32, 9-31
- Sweller, J., Chandler, P., (1994). Why some material is difficult to learn. *Cognition and instruction*, 12, 185-233
- Yeung, A., Jin, P., & Sweller, J. (1997). Cognitive load and learner expertise: split attention and redundancy effects in reading and explanatory notes. *Contemporary educational psychology*, 23, 1-21
- Yeung, A., S. (1996). Cognitive load and learner expertise: Split attention and redundancy effects in reading with explanatory notes. Unpublished doctoral dissertation, University of New South Wales, Australia