2015

Self-management of cognitive load in accounting within a Zimbabwean University context

Seedwell Tanaka Muyako Sithole
University of Wollongong, stms959@uowmail.edu.au

Self-management of Cognitive Load in Accounting Within a Zimbabwean University Context

A thesis submitted in fulfilment of the requirements
for the award of the degree
Doctor of Philosophy

from
UNIVERSITY OF WOLLONGONG

by

Seedwell Tanaka Muyako Sithole
B.Acc. Honours (Accounting), M. Science (Fin. & Invest.)
ACIS (Accounting & Admin), AIPA (Australia)

Faculty of Business
School of Accounting, Economics, and Finance

2015

Certification

I, Seedwell T.M. Sithole declare that this thesis, submitted in fulfilment of the requirements of the award of Doctor of Philosophy, in the Faculty of Business, School of Accounting, Economics and Finance, University of Wollongong, is wholly my work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

____

Seedwell Tanaka Muyako Sithole
August 2015

Abstract

Students frequently struggle with poor instructional design. A common example of poor design is where students are required to split their attention between several sources of information found in textbooks and other documents. Learners need to mentally integrate two or more distinct items of information, and this places unnecessary demands on cognitive load. Cognitive load theory assumes that the task of mental integration increases the load on already limited working memory, and it does so to such an extent that learning may be severely impeded. This thesis investigates how students could deal with cognitive overload when learning introductory accounting using three instructional design formats, the split-attention format, the integrated format, and the self-managed format. Two experiments investigated whether students who learned under the self-managed load format would outperform students in both the conventional split-attention format group and an instructor-managed integrated format group. In the two experiments, participants were randomly assigned to the three conditions.

The results of Experiment 1 established the presence of the split-attention effect as both the self-management and integrated groups obtained higher test scores and reported lower levels of cognitive load than the split-attention group. Experiment 2 also tests whether students in self-managed learning environments transfer learning skills gained from Experiment 1 to new learning environments in Experiment 2. A strong transfer effect for self-managed instructions was reported.

Dedication

This thesis is dedicated to the memory of my parents, Josiah Mwashonga Sithole and Hazzie Sithole, who believed in the value of education.

Acknowledgements

Foremost I would like to express my sincere gratitude to my supervisors, Professor Ed Arrington, Professor Paul Chandler, and Professor Indra Abeysekera. I could not have asked for a better team of supervisors. They made my Ph.D. experience productive and stimulating. Each of them was inspirational, supportive, and patient. I am forever grateful to Professor Ed Arrington who guided me and suggested various improvements to my research. I am thankful for his steadfast integrity and selfless dedication to my academic development. Professor Paul Chandler is a mentor, from whom I have learned the vital cognitive load theory. His insights and scrutiny of my research have been invaluable. The inspiration and enthusiasm during my PhD was phenomenal. My deepest thanks goes to Professor Indra Abeysekera for his assistance in getting my PhD started. In the School of Accounting, Economics and Finance I am grateful to Dr. Anura De Zoysa, Dr. Shyam Bhati, Dr Parulian Silaen, Dr. Kathy Rudkin, and Dr. Corinne Cortese for their input, valuable discussions and accessibility.

I would also like to gratefully acknowledge the funding for my Ph.D. This thesis was made possible through a UOW International Postgraduate Tuition Award (IPTA). Thank you University of Wollongong for the generous financial support.

My time at the University of Wollongong was enjoyable due to all my friends and colleagues within the Faculty of Business and cognitive researchers at the Early Start Facility. Their important feedback during my presentations was very helpful. I would also like to thank Innocent Chinyemba for his help with printing the instructional materials and for assisting with data collection, scheduling and conducting the experiments. l am grateful to all the participants for their consent to be involved in the experiments, without which this thesis would have been unsuccessful.

Finally l also pay tribute to my loving, supportive, encouraging, and patient wife, Getrude, as well as my children Vincent, Eustice and Angelica who missed me during the work on my thesis.

Table of Contents

List of Tables

List of Figures

List of Special Names or Abbreviations

ANOVA	Analysis of Variance
CLT	Cognitive load theory
Course	is the complete programme of studies needed to complete a university degree
CR	Credit
DR	Debit
IASB	International Accounting Standards Board
LTM	Long-term memory
STM	Short-term memory
Subject	is a unit of learning that normally lasts one academic period, and is managed by an instructor

Chapter 1: Introduction to the Study

1.1 Need for the Study

Presenting text and diagrams together rather than apart in instructional material has repeatedly been shown to enhance learning when compared to studying separate text and diagrams. Figures 1.1 and 1.2 illustrate this in a conventional geometry problem and its solution.

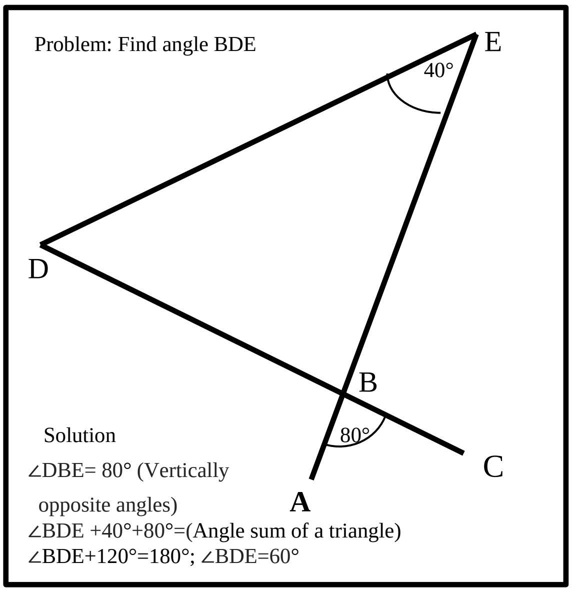


Figure 1. 1: Split attention format.
Source: Ayres & Sweller (2005:208).

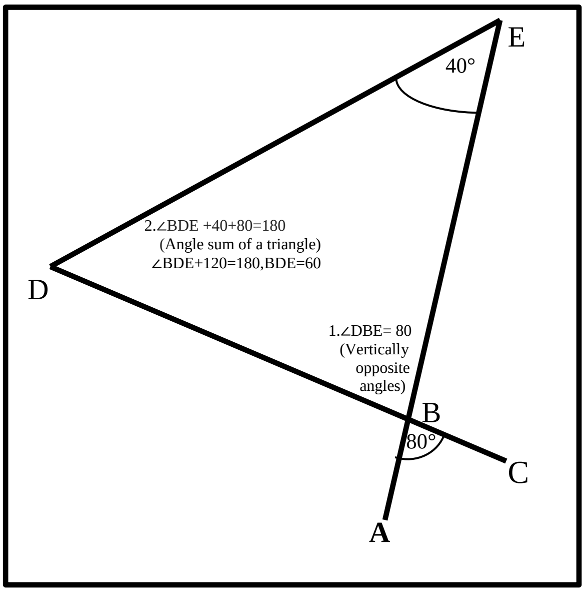


Figure 1. 2: Integrated format.
Ayres & Sweller (2005:209).

In Figure 1.1 the diagram is above the text which outlines the solution to the problem. The diagram and the text are presented separately. In processing the information from the diagram and text below it, the learner has to understand the solution steps and the linkage with the diagram and mentally combine the two sources of information. This requires considerable cognitive resources, which is not directly related to learning. Very little resources are then available for learning. In the case of novice learners, like most introductory accounting students, this is particularly important as they lack the proper schemas to integrate the new information with their previous knowledge (Ayres &

Sweller, 2005; Florax & Ploetzner, 2010; Morrison, Dorn, & Guzdial, 2014). In the integrated worked example (see Figure 1.2), the learner focuses on the relational dimensions of the problem, because his or her mental capacity is released from the need to search and match the solution steps and the linkage with the diagram.

As Agostinho, Tindall-Ford and Roodenrys (2013) explain, this searching and matching is both inefficient and has a negative effect on learning. It is quite common for students to encounter more than one externally presented source of information in introductory accounting instructional material and textbooks. As an example, let’s take just one topic in an introductory accounting textbook: adjusting the accounts. What students probably have to rely on for adjusting the accounts of prepayments, accruals and so forth is about 10 to 15 pages of text, journals, and T-account diagrams. As an instructor, the text and diagrams would seem reasonably clear and logical. For students, assimilating this dispersed information into successful problem solutions can be difficult (Mostyn, 2012; Sweller, Ayres, & Kalyuga, 2011). This introduces complexity as each of the various sources of information requires integration with other sources of information before it becomes intelligible (Chandler & Sweller, 1992; Mayer & Moreno, 2002; van Bruggen, Kirschner, & Jochems, 2002). The sheer volume of widely available learning materials, printed and online, has increased the availability of content but has not eased and perhaps enhanced the difficulty in learning introductory accounting (Abeysekera, 2008). Fortunately for classroom instruction, there is evidence that instructors manipulate text and diagrams by integrating them to enhance learning (Florax & Ploetzner, 2010; Tindall-Ford, Agostinho, Bokosmaty, Paas, & Chandler, 2015). Such integrational techniques are very common.

Students’ self-management consists of techniques to integrate conventional text and diagrams by underlining, arrows, highlighting or online movement of text as close as possible to parts of the diagram (Roodenrys, Agostinho, Roodenrys, & Chandler, 2012). The aim is to make the structure of instructional material beneficial to a learner without

adding new content-related information to this message (Mautone & Mayer, 2001). This is particularly useful for students accessing online learning material and during self-study when reading textbooks. However, most research to date has focused on how instructors or instructional designers can optimally design learning material and not on how students themselves can manage the instructional material (Agostinho, Tindall-Ford, & Bokosmaty, 2014; Roodenrys et al., 2012). This research is an attempt to close that gap, focusing on teaching self-management techniques and then compare possible efficiencies particularly in transfer effects.

Self-management techniques serve as a cognitive aid for learning in that they vary the way a learner will focus on instructional material by making the interrelations among relevant information salient (Mautone & Mayer, 2001, 2007; Roodenrys et al., 2012). Accordingly, several researchers have recently investigated how performance is affected by students self-managing instructional material (e.g., Roodenrys et al., 2012; Agostinho, Tindall-Ford, & Bokosmaty, 2014) as will be discussed later.

The above discussion is guided by CLT. The deployment of CLT, as part of introductory accounting instructional design, is appealing due to the robust way in which its general principles apply to a wide variety of instructional settings. Academic literature across various disciplines is replete with reports of improved learning outcomes in educational environments that apply CLT (e.g., Blayney, Kalyuga, & Sweller, 2010; Chandler & Sweller, 1991; Clark, Nguyen, & Sweller, 2006; Florax & Ploetzner, 2010; Kalyuga, Ayres, Chandler, & Sweller, 2003; Paas & Van Gog, 2006; Mayer, 2001, 2005; Moreno & Mayer, 2002; Samur, 2012). Despite this considerable empirical achievement, the application of cognitive load theory to accounting instructional material is, to my knowledge, very limited. Other disciplines report productive use of CLT design in areas like mathematics, engineering, computer science and educational psychology (Bunch & Lloyd, 2006; Wouters, Paas, & Van Merriënboer, 2008; Lovett & Greenhouse, 2000; Mostyn, 2012).

This chapter provides an overview of why studying introductory accounting is difficult although it is a vital subject in universities. It further examines the use of CLT for instructional design of accounting material in more detail. The chapter summarises CLT principles in the context of accounting instructional material. This is followed by an outline of the study at the conclusion of the chapter. Chapter 1 aims, in particular, to explain that, while most novice accounting learners find the introductory accounting subject difficult, such difficulties can be mitigated by using CLT design principles in design of instructional materials.

1.1.1 Overview of the Importance of Introductory Accounting

The first-year introductory accounting subject is a foundational subject in most undergraduate business curricula and even in some non-business programs (Duchac & Amoruso, 2011; Mostyn, 2012). Introductory accounting usually has very high student numbers. The student cohort is complex and consists of diverse groups of students with or without prior accounting education and/or experience. In fact, Wood (2012) states that the subject is mostly populated by non-accounting students. In the case of Zimbabwe, all business students in various universities are required to study an introductory accounting subject. In addition, many students from other faculties study introductory accounting as an elective.

The importance of introductory accounting is highlighted by the cluster of academic research which has focused on the introductory accounting subject (see for example, Albrecht & Sack, 2000; Almer, Jones & Moeckel, 1998; Bashir, 2000; Ingram & Howard, 1998; Miglietti, 2002; Mostyn, 2012). Since accounting tends to be taught in a linear progressive way, each subject builds on the knowledge acquired in prior accounting subjects. Second and third-year students are therefore quite dependent on the quality of learning in the introductory accounting subject.

1.1.2 Knowledge and Skills Set in Accounting and Students' Challenges When Learning an Introductory Accounting Subject

Cognitive load refers to the total amount of mental effort being utilised by the limited human working memory (Van Gerven & Pascal, 2003). CLT has developed instructional design guidelines that allow students to utilise their memory capacity as effectively as possible in order to assimilate more information and avoid the limitations of working memory (Cowan, 2014; Sweller, Ayres, & Kalyuga, 2011; Van Merriënboer & Sweller, 2005). They include, for example, the structure of learning material and modality. These will be discussed at large in Chapter 4.

Within this context, students studying introductory accounting are expected to attain various sets of knowledge and skills (Albrecht & Sack, 2000). The CPA Vision 2011 Project highlighted core accounting competencies needed as (a) communication and leadership skills, (b) strategic and critical thinking skills, and (c) the ability to meet the changing needs of clients, employers, customers and markets (AICPA, 1999). According to the report, accountants are expected to develop a broad range of techniques including facilitation, teamwork and "people skills" far beyond traditional written and oral skills to enhance the delivery and effectiveness of accounting services.

There are various examples of other studies with similar findings. Blanthorne, Bhamornsiri, & Guinn (2005) investigated the skills necessary for promotion and success in public accounting and found that the skills varied depending on the level of employee – senior accountant, manager, or partner. For the senior accountant and manager ranks, technical, communications, and interpersonal skills were most important, whereas for the partner rank, interpersonal, leadership, and communication skills were the most important. A study by Moncada & Sanders (1999) examined the perceptions of accounting students, faculty and CPA firm recruiters regarding what characteristics were most important for students trying to get accounting jobs by ranking the relative importance of 19 characteristics. While technical accounting competence

was listed as most important for all groups, evidence of leadership, writing skills, oral communication skills, maturity, and ethical standards were all highly ranked. A content analysis study of job descriptions, student resumes, course syllabi, and business textbooks found a gap between what is taught in business schools and the skills expected and needed by the hiring companies (David, David, & David, 2011).

Various factors have been identified as contributing to the lack of knowledge and skills. The first challenge relates to the understanding of accounting language, a complex and diverse phenomenon. Some examples of that diversity are shown in Table 1.1. The first two columns show UK and US terms, and the final column shows the terms used by the International Accounting Standards Board (IASB). The IASB uses a mixture of UK and US terms. Students and graduates confront all of these terms.

Table1.1: *Examples of IASB, US, and UK Terms*

IASB	**US**	**UK**
Shares	Stock	Shares
Inventory	Inventory	Stock
Receivables	Receivables	Debtors
Treasury shares	Treasury stock	Own shares
Finance lease	Capital lease	Finance lease
Payables	Payables	Creditors
Uniting of interests	Pooling of interests	Merger
Sales (or revenue)	Sales (or revenue)	Turnover
Associate	Equity accounted affiliate	Associate
Income statement	Income statement	Profit and loss account

Source: Alexander & Nobes (2010:9)

Considerable evidence reveals that the study of introductory accounting is increasingly proving more and more challenging for students (Albrecht & Sack, 2000; Borja, 2003; Mostyn, 2012; Saunders & Christopher, 2003). Borja (2003) found that students view introductory accounting as just as difficult as learning to speak a foreign language. There are serious consequences for this. For example, Albrecht and Sack (2000) investigated a decline in the number of students majoring in accounting. Seventy nine

percent of accounting practitioners and almost 100 percent of accounting educators who responded to their surveys stated that they would choose a different major if given a second chance. The authors contend this response is mainly due to curricula and teaching methods. They highlighted that there is too much emphasis on memorisation, which is not conducive for quality learning outcomes.

Perhaps more important to the introductory accounting subject, students experience difficulty when introduced to foundational threshold concepts (Lucas & Mladenovic, 2007). For example, learners struggle to understand concepts such as subjectivity, and the realisation that value, profit, cost and cash have different meanings in different contexts, and yet this base is fundamental for advancing understanding and proficiency in the accounting discipline. Students studying an introductory financial accounting subject for the first time are in the early stages of studying the subject and yet face large amounts of information that may appear isolated conceptually. In fact, learners may grasp specific accounting principles but may fail to recognise the interrelated aspects of the concepts within an organising or explanatory structure (Lucas & Mladenovic, 2007). Contrary to the assumptions of many novice accounting students, understanding financial accounting is not about knowing a set of rules and procedures to commit to memory and apply mechanically; instead, it is a framework for analysing evolving business transactions and making informed decisions in increasingly complex environments (Bloemhof & Christensen, 2013).

Language and concepts are not the only challenging issues for learners. First-year accounting students frequently view the subject as highly analytical with exact answers that are either correct or wrong. The following simple example illustrates that this is an incorrect view. Assume two companies who value their inventory using different accounting methods. Company X chooses LIFO (last-in, first-out) and Company Y selects a different method, FIFO (first-in, first-out). These two methods give totally different but equally “correct” answers. However, for a student studying accounting for

the first time, this may be incomprehensible. This is not the only instance; accounting has several almost “incomprehensible” conventions that are applied to produce equally precise and mystifying financial reports that can only be fully decoded by other accountants (Blackstaff, 2006). Introductory accounting requires students to master many concepts such as assets, equity, liabilities and procedures, such as estimating depreciation expense and the preparation of financial statements. These typically require conceptual and procedural mastery with recall-type questions demanding a precise correct answer giving students no reason to consider potential ambiguities.

Traditional presentation methods may be counter-productive in overcoming these problems. Research has shown that many learners leave the introductory accounting subject without understanding accounting concepts at the level expected by instructors (Mostyn, 2012; Roberts, Kelley, & Medlin, 2007). Undoubtedly, one of the causes for this is the enormous amount of information, consisting of accounting concepts and procedures that are interrelated and must be understood. The technical demands found in the introductory accounting subject have often led to poor student perceptions of accounting, failure and discouragement (Albrecht & Sack, 2000). Moreover, the traditional presentation in accounting instructional material is almost always an example of split attention (Chandler & Sweller, 1992; 1996; Ginns, 2006). Of course, numerous other factors affect students’ performance, factors like teaching methods used (Leveson, 2004, Heikkila & Lonka, 2006), ethnicity, gender, age (Patricia, Chen, Huang, Chiang, Jen, & Warden, 2006), variations in motivation of students (Lucas, 2001), and even the type and location of the institution (Yvonne & Kola, 2010; Lloyd & Abbey, 2009). In summary, these sections have highlighted the high complexity of introductory accounting. This makes it a fertile area for the testing of cognitive load theory.

1.2 Emergence of CLT and its Application to Other Disciplines to Enhance Learning

Study of pedagogical approaches can be traced as far back as the early and mid-twentieth century. Lev Vygotsky, John Dewey, and Edward Thorndike are mostly thought to be the well-known learning theorists throughout that period. Mostyn (2012) states that their philosophies provided the foundation for the growth of the major schools of thought we currently possess. These are loosely grouped under the rubrics of either Behaviourism or Constructivism.

1.2.1 Behaviourism and Constructivism

Behaviourism, one of the first schools of thought, was extensively applied for almost twenty years although it is far less common today. Constructivism developed throughout the twentieth century and endures even today. Mostyn (2012) states that constructivism assumes that human beings build their understanding and knowledge of reality predominantly in the framework of their social interactions and personal experiences, which inevitably mediate the results of any learning process. All constructivist approaches highlight the role of an instructor, mainly as a facilitator or coach who decides the subject areas and engages as well as advises students in an interactive way. Cogntitive load theory is embedded in the constructivist paradigm.

1.2.2 Cognitive Load Theory

Cognitive load theory is an instructional theory based on our knowledge of human cognitive architecture that assumes unlimited long-term memory and a limited capacity of working memory (Roodenrys et al., 2012). Information is assumed to be stored in the form of schemas (Sweller, 2015). Human cognitive architecture relates to working (short-term) memory, sensory memory, long-term memory, and memory structures which have been hypothesized as essential to how students learn, think and solve problems (Sweller, 2004). This will be discussed at large in Chapter 3. On the other hand schemas are an organised pattern of thought or mental structures that organise

categories of information and the relationships among them (Paas & Ayres, 2014). Learners use schemata to organize current instructional knowledge and to provide a framework for future understanding.

Cognitive load theory (Paas, Renkel, & Sweller, 2004; Sweller 1988; Van Merriënboer & Sweller, 2005) has developed into an influential theory during the past two decades in the fields of instructional design and educational psychology. For example, Ozcinar (2009) examined research publications in instructional design for the period 1980–2008 and established that "cognitive load theory" was the second most frequently used phrase. Out of the top ten most cited articles, six related to cognitive load theory. Furthermore, Jones, Fong, Torres, Yoo, Decker & Robinson (2010) examined productivity in the top five educational psychology journals from 2003 to 2008. They found that 4 of the top 20 most productive researchers use CLT as a central theory in their work.

CLT identifies three types of cognitive load that can be imposed on working memory: intrinsic cognitive load, germane cognitive load, and extraneous cognitive load (Cowan, 2014; Morrison et al., 2014; Sweller et al., 2011). Intrinsic cognitive load is brought about by the inherent level of difficulty connected with a particular instructional topic. Germane cognitive load is the load committed to the construction, processing and automation of schemas. The final one is extraneous cognitive load which is the focus of this study. Extraneous cognitive load occurs as a result of the burden imposed on working memory by either the way in which the information is organised or the activities in which the learner must engage (Sweller et al., 2011). Extraneous cognitive load can result from poorly designed instructional material. Making sense out of split-attention instructions, for example, imposes a very heavy extraneous load.

While CLT research explores a broad range of design issues as they relate to CLT, this study will narrow the focus to a particular aspect of design termed "the split-attention

effect” (Ayres & Sweller, 2005; Clark et al., 2006; Florax & Ploetzner, 2010; Kalyuga, Chandler, & Sweller, 1999; Liu, Lin, Tsai, & Paas, 2012). Mayer & Moreno, 1998; Tarmizi & Sweller, 1988). The split-attention effect occurs when students are required to integrate and process multiple and split sources of information (Carlson, Chandler, & Sweller, 2003). The typical example is separating text from a related diagram (see Figure 1.1). Most introductory accounting materials follow this split format, imposing a high extraneous cognitive demand on working memory. A meta-analysis of the split-attention effect has shown that integrated instructional formats which avoid split design reduce extraneous cognitive load and improve learning (Ginns, 2006).

Over a decade and using a variety of experiments, Chandler, Sweller and colleagues observed that integrated diagrams were superior for learning and enhanced students’ performance (Chandler & Sweller, 1991, 1992; Owens & Sweller, 2008; Ward & Sweller, 1990). This research extends to a variety of disciplines such as engineering and mathematics. By simply combining formulas or texts with diagrams, students found it simpler to integrate and process both forms of visual information and in turn they performed significantly better (Clark et al., 2006; Florax & Ploetzner, 2010).

1.3 Justification for the Inclusion of CLT as Part of Introductory Accounting Instructional Design

As indicated in the preceding section, investigation in various disciplines has reported the superiority of integrated worked examples as compared to the split-attention format learning material in computer software instruction (Kalyuga et al., 1999), in electrical engineering (Chandler & Sweller, 1991), finance (Kissane, Kalyuga Chandler, & Sweller 2008), mobile learning in physical environment (Liu et al., 2012), and in music instruction (Owens & Sweller, 2008).

Despite the extensive CLT research and its widespread application in instructional design for many other fields, very little discussion has appeared in the accounting

education literature (Mostyn, 2012). Interestingly, Mostyn (2012) performed a literature review during the latest ten-year period and only identified two articles applying CLT principles to accounting (Halabi, Tuovinen, & Farley, 2005; Halabi, 2006). Where research has been carried out in the accounting discipline, it has tended to focus on a few CLT effects such as the expertise reversal effect (Blayney et al., 2010), and the worked example and problem completion effect (Halabi et al., 2005). Kissane, Kalyuga and Sweller (2008) investigated the consequences of fading instructional guidance on delayed performance in the discipline of finance. To the best of my knowledge, no accounting research studies have examined split-attention effects.

An important advantage of CLT has been that it provides an explanation, based on human cognitive architecture, as to why some content is difficult to learn. It has shown the capacity to empirically replicate studies that describe the human cognitive process which has some remarkable similarities to the evolutionary development of computer architecture—such that general principles can be developed that apply in a wide variety of instructional applications (Mostyn, 2012). In addition CLT provides guidelines for effective instructional design for novices in complex areas such as accounting to facilitate schema acquisition, development and automation.

Specifically in the area of accounting, this thesis argues that in learning introductory accounting, learners split their attention among various sources in order to understand and use the instructional materials provided. For example, one of the first topics in introductory accountancy requires understanding the accounting equation, and novices find it difficult to understand (Sangster, 2010). There are two difficulties presented by the accounting equation. First, equations in general are by their very nature high in element interactivity (Blayney, Kalyuga, & Sweller, 2015; Sweller, 2004). Element interactivity refers to the many elements that should be processed concurrently during the learning process. Secondly, they present a split-attention effect, which is the main focus of this thesis. In the accounting equation split-attention occurs when learners are

required to refer to the equation and spatially separated text explaining the components of the equation.

1.4 Learning Introductory Accounting

Many students are introduced to the accounting equation and the preparation of journal entries during the first few days of an introductory accounting class. Students are taught the fundamental basic accounting equation from which all financial accounting systems develop (Scofield & Dye, 2009). Although some financial accounting textbooks vary the emphasis on the accounting equation, accounting students are expected to understand accounting equation effects (Phillips & Heiser, 2011). It is important to note that there are various ways to present journal entry instruction in practice. Learners may be expected to explicitly think about the effect on the accounting equation before proceeding to prepare a journal entry (e.g., Spiceland, Thomas, & Herrmann, 2009) or after preparing each journal entry (e.g., Harrison, Horngren, & Thomas, 2010). Whatever approach is used, it is quite complex for the learner in as much as it assimilates the analytical demands imposed by the debit/credit structure of bookkeeping.

To better illustrate the demands on the memory of the learner, the various steps in the journal entry preparation process need to be understood. Table 1.1 summarises the sequential steps that learners have to go through when analysing a transaction in order to prepare journal entries.

Table1.2: *Transaction Analysis Steps*

Step 1: Acquire information	Read transaction information
Step 2: Picture the exchange	Identify what is given and received
Step 3: Name the accounts	Choose appropriate account labels
Step 4: Analyze the effects	Determine whether accounts increase or decrease
Step 5: Determine debits/credits	Decide whether to debit or credit the accounts
Step 6: Prepare journal entry	Express transaction effects in journal entry format

Source: Phillips & Heiser (2011:684).

The transaction analysis will present a number of challenges for learners; for example, attempting to identify the items involved in an exchange. This would involve several variables, including the determination of who is involved in the exchange, what is given and what is received. Learners must apply their knowledge of transaction rules to determine whether an accounting transaction has taken place. Learners then have to choose (step 3 and 4) which particular account to debit or credit. They have to know the basic accounting formula which states that assets (A) equal liabilities (L) plus equity (E). This step may result in confusion for students because debits and credits can cause either an increase or a decrease depending on the type of account (Phillips & Heiser, 2011). That is, in terms of the accounting language debits increase and credits decrease asset accounts, whereas debits decrease and credits increase liability and equity accounts. Novice learners must identify the category to which each account belongs and recall the effect of a debit or credit in relation to increasing or decreasing that category of account.

The analysis of equity and in particular revenue and expense accounts adds complexity because debits decrease equity, while credits increase equity. Instructors and textbooks also provide a variety of other information relevant to this analysis, including illustrations (e.g., T-accounts), and written summaries showing the rules of debits and credits above or below the accounting equation. The final step (Step 6) of preparing the journal entry requires a combination of processes: understanding how each transaction affects the account category; the appropriate specific account names; identifying the directional effects of the transaction; and, knowledge of the rules of debits and credits. Obviously, significant demands are placed on working memory, which instructors and textbook writers have tried to alleviate by presenting diagrams and related texts explaining the directional effects of a transaction on elements of the accounting equation. This analysis has been shown to demonstrate the high complexity and high element interactivity of accounting

1.5 Outline of the Thesis

The remainder of this study is organized as follows:

Chapter 2 reviews various difficult aspects of learning in introductory accounting subjects. Chapter 3 outlines the relevant human cognitive architecture for the context of this study. Human cognitive architecture and its main structural elements, long-term and working memory, and a review of several cognitive processes and memory models are presented. The chapter discusses the view that human beings are information processing organisms with a poor working memory but an excellent long-term memory and discusses the implications of this for learning. Chapter 4 provides a foundation for the theoretical rationale for the research reported in this thesis. The chapter focuses on instructional design guidelines relevant to CLT effects that aim to decrease cognitive load arising from poorly designed instructional material. Chapter 5 discusses the studies which explore self-management of split-attention. It builds on other CLT effects presented at the end of Chapter 4. Chapter 5 discusses more recent findings which show that instructional formats requiring students to self-manage may decrease the load on working memory. Chapter 5 also discusses the need to continue investigating techniques that learners can use to overcome poorly constructed learning materials. Chapter 5 also presents the research questions that motivate this thesis:

- Are self-management instructional formats and integrated instructional formats superior to conventional split-attention instructional formats in both recall and transfer tests?
- Do students in the self-managed instructional format group outperform students in the integrated instructional format group?
- Does use of an integrated instructional format yield better performance than a split-attention instructional format on recall and transfer test items?

In relation to mental effort (cognitive load) the following issues were addressed:

- Do students in the split-attention format report higher effort (cognitive load) than students in the self-managed format?
- Do students in the self-managed format group report lower cognitive load than students in the integrated format group? and,
- Do students in the integrated format group report higher cognitive load than students in the split-attention format?
- Do students in the self-managed format group use guidance to self-manage and report lower cognitive load than students in the integrated format and split-attention groups.

Chapter 6 discusses the design of the experiments in order to answer the questions raised in Chapter 5. Chapter 7 explores the results of the experiments in this thesis. The final chapter (Chapter 8) provides a brief review of the major findings and discusses implications of the conclusions for instructors and learners, researchers and theorists, and textbook writers. The chapter then discusses limitations of this thesis and offers suggestions for future research into the understanding of self-management of cognitive load effects in an introductory accounting context.

Chapter 2: Elements of Difficulty in Introductory Accounting

2.1 Introduction

Chapter 1 discussed the need for the study. This chapter is designed to give readers who are unfamiliar with accounting some insight into the nature of material in the introductory accounting subject.

This chapter acknowledges that there is vast research literature in accounting education journals, which is important once we recognise the need to improve student learning outcomes within the area of introductory accounting. Within that context, more research focus on the design of introductory accounting instructional material is needed. A brief discussion of the difficulty in introductory accounting with respect to design issues is presented in this chapter, followed by other, related instructional difficulties. Finally, challenges for accounting learners and academics concerned to mediate split attention and other difficulties are presented.

Students learning accounting for the first time often start by learning the double-entry system and generally find it difficult to correctly prepare the necessary journal entries (Sangster, Franklin, Alwis, Abdul-Rahim, & Stoner, 2014). To be specific, they struggle with the initial stages of the double-entry procedure: classifying accounts that need to be credited or to be debited. Bouwman (1998) states that while students fear the subject of accounting, the reason for this fear has to be more than a dislike for numbers or a math skill deficit because “the math is not all that demanding, particularly at the introductory level” (pp. 17, 18). What, then, causes an introductory accounting subject to be difficult?

2.2 Determination of Difficulty in Introductory Accounting

Bouwman (1998) suggests a number of answers as to why introductory accounting is a difficult subject. Strategies to reveal that difficulty include surveying students directly as

to why they consider accounting to be difficult, studying the specific reasons that make some items seem more difficult than others, and comparing the manner in which alternative formats of material produce different levels of difficulty. This study focuses on the third strategy since the concern here is with the design of accounting instructional material.

Baxter and Glasser (1998) support Bouwman's (1998) suggestions. Figure 2.1 below outlines how instructional material difficulty can be identified with the cognitive demands of an item, subject matter knowledge required by the item, and the format or type of item under consideration.

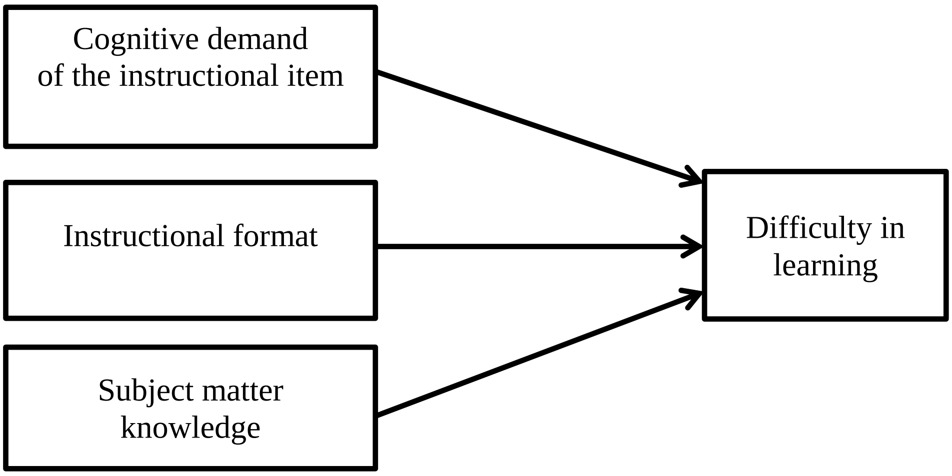


Figure 2.1: Conceptual model of instructional material difficulty.

Adapted from Baxter & Glasser (1998:38)

2.3 Instructional Content Details of Introductory Accounting Subject

The component of the above conceptual model of instructional material difficulty relevant for this study is the instructional format. Prior research has shown that the format, the form of activity required to manipulate or interpret knowledge, is an important consideration when attempting to address the difficulty associated with introductory accounting subject matter (Baxter & Glasser, 1998).

The introductory accounting subject is concerned with basic accounting concepts and procedures. "The first accounting subject is traditionally an introductory financial accounting subject with the major emphasis being on the mechanical, bookkeeping aspects of financial accounting ... By the second week, students were being taught debits and credits, and journals and ledgers" (Saudagaran 1996:85). A holistic understanding of the subject can be grasped through attention to the accounting cycle, which involves several stages of transactional analysis and production of financial statements. For the sake of conciseness, this chapter will focus on only the accounting cycle and one financial statement - - the Statement of Financial Position (Balance Sheet).

2.4 Difficulty of Basic Accounting Concepts in Introductory Accounting

Learning accounting for the first time brings enormous challenges to novices in this learning domain. The first of these is the discursive challenge posed by specialised financial accounting terminology and rather ambiguous accounting concepts (King & McConnell, 2010). The concept of double entry encountered for the first time is often found to be mysterious to even the most able students. As accounting information is written in the form of debits and credits, understanding what constitutes a debit and a credit is puzzling. This is further complicated by the fact that an increase or decrease in a debit or credit is not expressed within the conventional logic in mathematics as positive and negative. The notions of debits and credits and the accounting equation becomes an exercise in complexity for those who are learning accounting for the first time.

Time demands and the amount of material create learning difficulties for introductory accounting students (Blayney et al., 2010). Another consideration is the intrinsic complexity of the learning content. These two factors converge when students must consciously process many interrelated elements of information quickly to render the material intelligible. This complexity has important instructional implications for teaching accounting. For example, learning introductory accounting requires

understanding the accounting equation, and novice learners to accounting find it difficult to understand (Sangster, 2010). It states that assets (A) equal liabilities (L) plus equity (E), and it looks like a simple equation A = L + E. However, in terms of the accounting language of debits and credits, the left side and the right side of the equation each deploy debits and credits. The debits increase and credits decrease assets (the left side of the equation), but debits decrease and credits increase liabilities and equity (the right side of the equation). Novice learners often find this logic difficult to understand and apply. Of particular relevance to this study, this complexity is deepened by presenting the explanatory text about the accounting equation and the rules about debit and credit separately. Such type of presentation generates a split-attention effect in the learner, which happens when a learner is required to mentally integrate two or more sources of information that cannot be understood in isolation (Mayer & Moreno, 2002; van Bruggen et al., 2002).

2.4.1 Complexity of Journal Entries and T-accounts

Once a student understands the economics of a transaction, the preparation of a journal entry begins. One approach requires students to explicitly consider the accounting equation effects of a transaction before proceeding to prepare a journal entry (e.g., Spiceland et al., 2009). An alternative approach encourages students to consider the accounting equation after preparing each journal entry, as a check on the equality of the accounting records (e.g., Harrison et al., 2010). The requirement to reflect on the accounting equation effects is supposed to help students understand accounting transactions. However, the need to consider multiple elements increases the demands on working memory, thereby sometimes contributing to poor performance.

The use of T-accounts compliments the journal entry process. It is an important part of teaching business transaction analysis in an introductory accounting subject. The T-account allows students to visualize the effects of business transactions on the accounting equation and also assists in the recording of journal entries. A T-account

contains just the basic elements of the account. Each account has a unique account name, for example Cash. In most cases an account number is placed along with the name in order to facilitate computer entry and report generation (e.g., Cash: 100). Immediately under the bar would be the debit and credit columns.

As shown in Figure 2.2, the T-account balance can be obtained by initially getting the total of each column. Second, the user needs to deduct the lesser total from the larger one, and lastly inserting the difference in the column with the smaller number.

Form:

Account name: Account number

Debit	Credit
Total	Total
Balance	Balance

Example:

Bank: 100

$1400.00	$ 100.00
130.00	160.00
	1270.00
1530.00	1530.00
1270.00	

Figure 2.2: An illustration of the form and example of a T-account.

Adapted from Weygandt, Chalmers, Mitrione, Fyfe, Kieso, & Kimmel (2010:52)

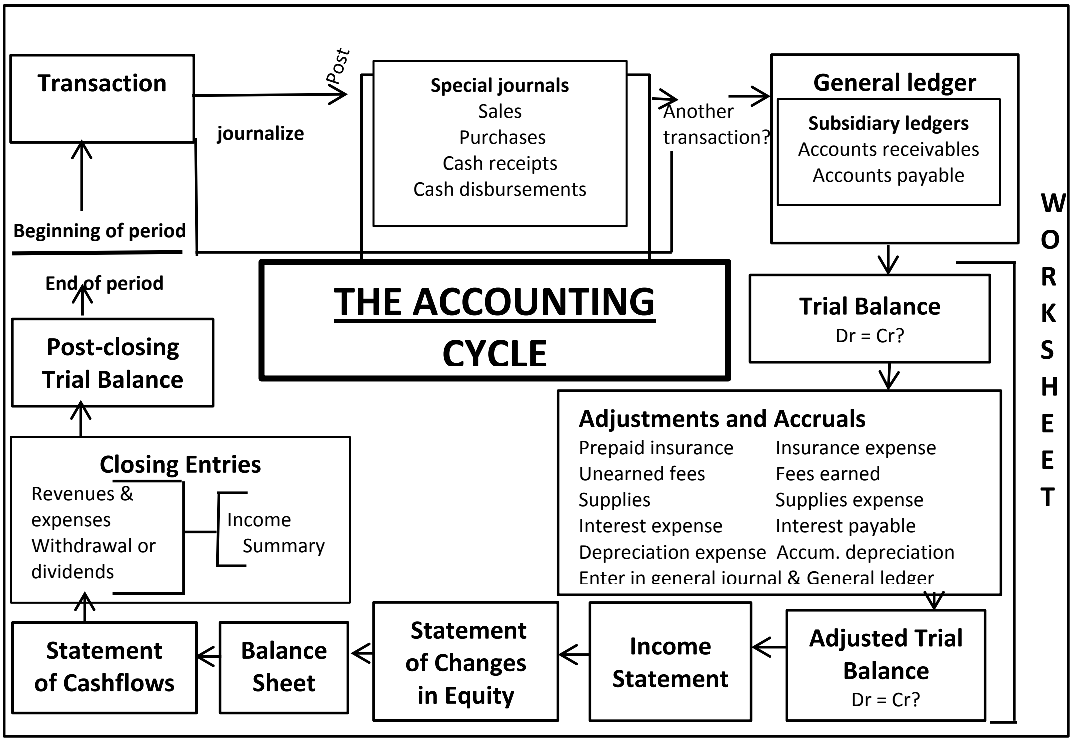
Although a T-account as presented above is used a demonstrative tool and a quick reference, it sometimes lacks the necessary detail to fully reflect the accounting process. Although a T-Account is helpful for briefly summarising the balance in an account, it merely holds a small portion of the learning material a student is required to master. A detailed explanation needs to accompany Figure 2.2. On the other hand providing a detailed explanation in addition to the figure introduces split-attention which, as previously discussed, may have deleterious effects on learning.

2.4.2 The Accounting Cycle

Every student, majoring in accounting or otherwise, needs to grasp the implications of the work the accountant performs and how to use the resulting financial statements. Therefore a student has to understand the accounting cycle and the financial statements and their accounts. These topics are fundamental to the understanding of introductory accounting (Boyd, Boyd, & Boyd, 2000).

Understanding the accounting cycle requires mastery of recording a transaction in a journal, posting from a journal to a ledger, preparing the adjusting entries, and finally preparing the financial statements. This is quite a comprehensive domain of knowledge. It captures the basic foundation for every entry performed in accounting. Every introduction to accounting textbook addresses the cycle, in words, numbers, imagery and graphically. It is thus easy to see how salient split attention problems are in this context, as represented. This sort of diagrammatic representation is in every textbook.
Students must also master separately presented textual material. There are nine steps that are normally textually explained below or above a diagram and they are presented in Figure 2.1.

Reading these steps and trying to relate them to the accounting cycle requires splitting attention between the diagram and text. The purpose of this brief digression into the narrative aspects of studying the accounting cycle is to show just how voluminous and complex learning processes can be. The challenge posed is only made worse by high levels of split-attention. For learning to occur the information of each source (i.e. the diagram and text) must first be mentally integrated by the learner. However, this required integration process increases demands on the student's limited working memory (WM) and may have quite negative effects on learning.



- **Transaction.** The accounting process starts with collecting and analysing data from business transactions or events. A source document serves as basis for recording a transaction. For example if a company purchases a vehicle, the source document is a receipt, and a new asset (vehicle) must be added to the books of accounts.
- **General journal.** Involves putting transactions into the general journal. A journal is an electronic or paper book in which transactions are recorded chronologically as they occur using the double-entry accounting system. For example, when a vehicle is purchased the value of the asset (vehicle) increases. Therefore we debit the asset account. If cash was used to buy the asset, then the bank account will be credited. Other transactions such as sales, purchases, cash receipts, and cash disbursements that occur frequently are recorded separately in the special journals.
- **General ledger.** Involves posting entries to the general ledger: A ledger is a collection of accounts that show the changes made to each account as a result of past transactions, and their current balances. The debit and credit values of journal entries are transferred to ledger accounts one by one in such a way that the debit amount of a journal entry is transferred to the debit side of the relevant ledger account, and the credit amount is transferred to the credit side of the relevant ledger account. After the posting process, the balances of each account can be calculated on the bottom of each ledger account.
- **Trial balance**. Involves preparing an unadjusted trial balance: an unadjusted trial balance is a listing of all the business accounts that are going to appear on the financial statements before year-end adjusting journal entries are made. It is prepared to test whether debits and credits are equal. All account balances are extracted from the ledger, and all debit and credit balances are added separately.
- **Adjustments and accruals**. Adjusting entries are prepared as an application of the accrual basis of accounting. At the end of the accounting period some expenses may have been incurred but not yet recorded in the books, and income may have been earned but not entered in the books. Therefore entries are made for accrual of expenses and income, deferrals, prepayments, depreciation, and allowances.
- **Adjusted trial balance**. This involves preparing an adjusted trial balance: an adjusted trial balance may be prepared after adjusting entries are made but before the financial statements are prepared. This tests if the debits are equal to credits after adjusting entries are made.
- **Financial statements**. Involves organizing the accounts into the financial statements. The financial statements are prepared when the accounts are up-to-date and the equality between the debits and credits has been tested. The financial statements are the end-products of an accounting system. The financial statements are made up of: (1) Income Statement (Statement of Comprehensive Income); (2) Statement of Changes in Equity; (3) Balance Sheet (Statement of Financial Position); (4) Statement of Cash Flows; and, (5) Notes to Financial Statements.
- **Closing entries**. Temporary or nominal accounts, which include income statement accounts, are closed to prepare the system for the next accounting period. Temporary accounts include income, expense, and withdrawal accounts. These items are measured periodically. The accounts are closed to a summary account (often, Income Summary) and then closed further to the appropriate capital account. Closing entries are made only for temporary accounts. Permanent accounts like balance sheet accounts are not closed.
- **Post-closing trial balance**. The last step is to prepare a post-closing trial balance. It is prepared to test the equality of debits and credits after closing entries are made. Since temporary accounts are already closed at this point, the post-closing trial balance contains real accounts only.

Figure 2.3: The accounting cycle
Source: Boyd et al. (2000:38)

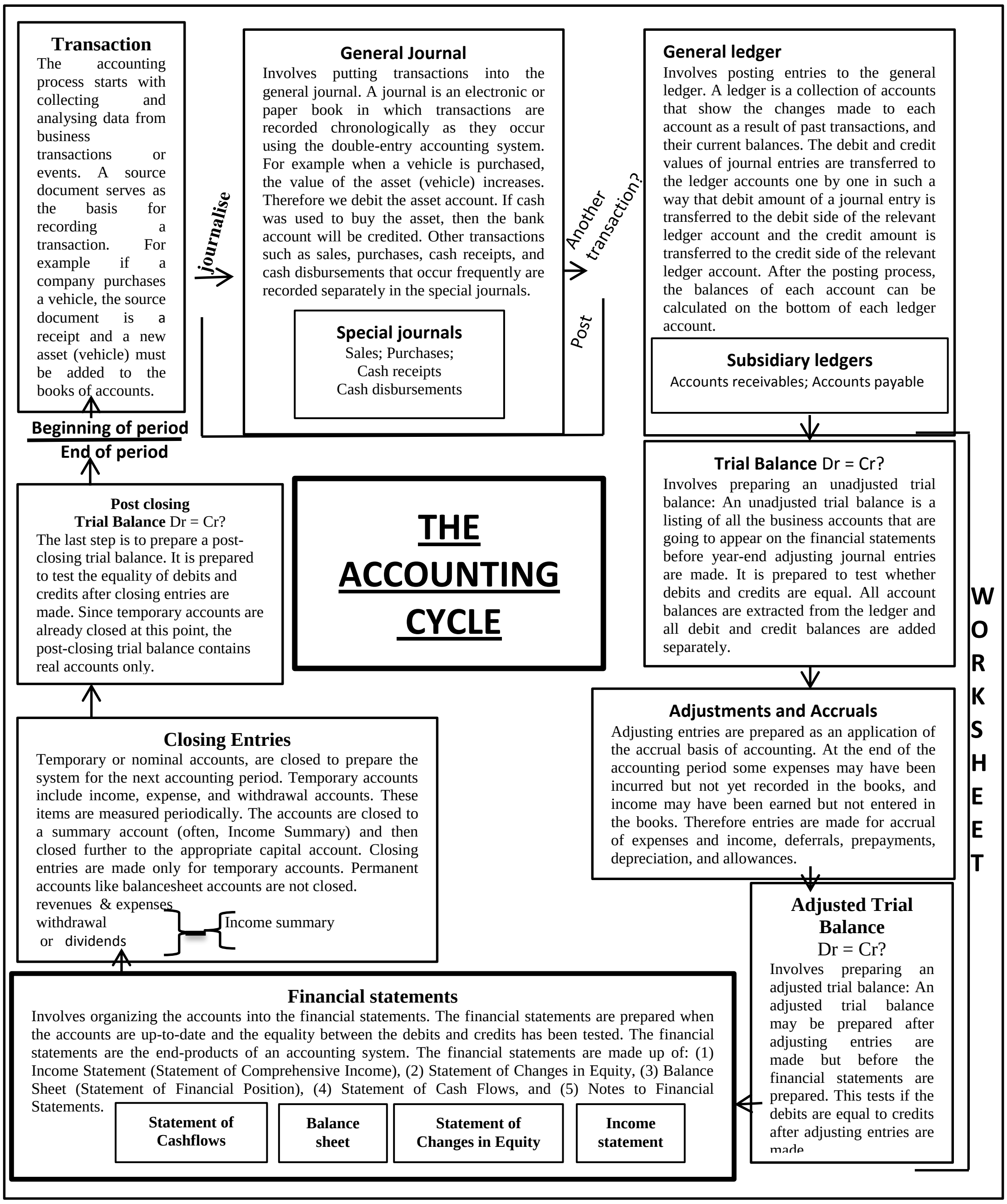


Figure 2.4: The accounting cycle (integrated format)

Source: Adapted from Boyd et al. (2000:38)

To create effective learning environments the accounting cycle could be integrated into a single source of information embedding the written steps within the diagram (see Figure 2.4). The level of “mental energy” required to process information in Figure 2.3

and the related text below it is more than is required for the same figure with text embedded within it (see Figure 2.4).

As the quantity of information that needs to be learnt increases, so too does the accompanying cognitive load (Cooper, 1990). As will be discussed in Chapter 4, useful learning material supports learning by directing cognitive resources to activities that are pertinent to learning rather than to processes that are adjuncts to learning. Figure 2.4 illustrates an integrated instructional format.

2.4.3 Statement of Financial Position (Balance Sheet)

A statement of financial position indicates the state of affairs of a business on a particular date. A statement of financial position is the culmination of a long and complex recording process that involves a record of transactions, posting to the respective ledger accounts, and the preparation of a trial balance as illustrated in the accounting cycle before. If the statement of financial position does not balance, mistakes have definitely been made during the preparation process; they will have to be found.

The public tends to regard the balance sheet as proof of both the difficult nature of accounting and of the technical competence and reliability of the accountants and auditors involved (Alexander & Nobes, 2010). Hoggett, Medlin, Edwards, Tilling and Hogg (2012) even call it one of the most baffling financial statements for a new business owner and notes the document's "magical" ability to convey total confusion to many. This thesis argues that part of the complication arises from the way the statement of financial position is presented. Most accounting instructional material provides diagrammatic presentation of a statement of financial position followed by an explanation of each of the components as contained in Figure 2.5 below, thus inducing the decrements to learning imposed by instructional design which evokes split-attention.

DON'S AUTO REPAIRS	
Balance Sheet as at 30 June 2012	
ASSETS	
Cash at bank	$ 50,340
Accounts receivable	77,790
Repair supplies	14,610
Repair equipment	110,700
Land	260,000
Building	455,000
TOTAL ASSETS	**$968,440**
LIABILITIES	
Accounts payable	80,760
Mortgage payable	401,000
TOTAL LIABILITIES	**481,760**
NET ASSETS	**$486,680**
EQUITY	
Don Brady, Capital	$486,680
TOTAL EQUITY	**$486,680**

Asset. Assets are resources controlled by an entity as a result of past events and from which future economic benefits are expected to flow to the entity. These economic benefits can be tangible (having physical characteristics) such as land, buildings and equipment or intangible (assets without physical existence) such as legal claims, or patent rights.
Liabilities. Liabilities are present obligations of an entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits. There are debts owed to outside parties called creditors, and they include amounts owed to suppliers for goods and services purchased on credit (accounts payable), amounts borrowed from banks and other lenders (loans payable and mortgages payable).
Equity. Equity may be thought of as owner's claims to (or the interest in) the assets of the entity after deducting all liabilities. Thus equity is a residual (i.e. "left over") claim on the assets.

Figure 2.5: Statement of financial position

Source: Hoggett et al. (2012:31)

A similar type of instructional presentation is used for other financial statements, such as the statement of comprehensive income and the cash flow statement. As has been stated in the preceding section, such separate text and diagrams require split-attention which does not enhance learning (Chandler & Sweller, 1992; Mayer & Moreno, 2002; van Bruggen et al., 2002).

DON'S AUTO REPAIRS	
Balance Sheet as at 30 June 2012	
ASSETS. Assets are resources controlled by an entity as a result of past events and from which future economic benefits are expected to flow to the entity. These economic benefits can be tangible (having physical characteristics) such as land buildings and equipment or intangible (assets without physical existence) such as legal claims, or patent rights.	
Cash at bank	$ 50,340
Accounts receivable	77,790
Repair supplies	14,610
Repair equipment	110,700
Land	260,000
Building	455,000
TOTAL ASSETS	**$968,440**
LIABILITIES. Liabilities are present obligations of an entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits. These are debts owed to outside parties called creditors and include amounts owed to suppliers for goods and services purchased on credit (accounts payable), amounts borrowed from banks and other lenders (loans payable and mortgages payable).	
Accounts payable	80,760
Mortgage payable	401,000
TOTAL LIABILITIES	**481,760**
NET ASSETS	**$486,680**
EQUITY. Equity may be thought of as owners claim to (or the interest in) the assets of the entity after deducting all its liabilities. Thus equity is a residual (i.e."left over") claim on the assets.	
Don Brady, Capital	$486,680
TOTAL EQUITY	**$486,680**

***Figure 2.6**:* Statement of financial position (integrated format)

Source: Adapted from Hoggett et al. (2012:31)

2.5 Challenges for Accounting Learners and Academics

Promoting a better understanding of introductory accounting can only be brought about by well-designed instructional materials. Accounting textbook writers have attempted to expose first-year accounting learners to many possible transactions that they may encounter, expanding principles of accounting textbooks to the extent of information overload (Boyd et al. 2000). To help overcome the information overload, students have to learn new ways of managing textbook and other sources of accounting content.

In recent years, research has addressed the question of what needs to be done in order to improve the level of accounting education. The question of what causes the perceived lower quality of some accounting students' academic and professional achievement is a common question with evasive answers. Academics are eager to provide practical

solutions that help students meet the academic requirements as well as meeting the high levels of employer expectations.
The challenge for academics is that introductory accounting encompasses specific areas which have usually proved demanding for students, and this has frequently caused negative perceptions about accounting (Wood, 2012; Lucas & Mladenovic, 2006). Instructors in accounting need to adopt new innovative instructional designs that challenge preconceptions of the subject and urge learners to acquire strong, in-depth knowledge that promotes effective learning.

As illustrated in this chapter, many accounting learning materials require learners to unnecessarily split their attention between diagrams and text. A different instructional format is to have related diagrams and text as physically close as possible to avoid the extensive search and match behaviour. This format is referred to as an integrated format. Ample research has shown that diagrams and text need to be integrated in order to overcome the deleterious effects on learning caused by split attention design (Ayres & Sweller, 2005; Chandler & Sweller, 1991; Clark et al., 2006; Kalyuga, Chandler, & Sweller, 1999; Mayer & Moreno, 1998; Tarmizi & Sweller, 1988). Consequently, this thesis goes a step further to investigate whether students can be instructed on how to integrate the materials on their own. As will be discussed later, this thesis will also examine students' ability to "self-manage" the consequences of split-attention design.

2.6 Chapter Summary

The objective of this chapter was to give a few examples of why certain elements of an introductory accounting subject are difficult to learn within the context of split-attention. The aim was to identify areas requiring instructional design improvement within the context of split-attention. To achieve this objective, a review of relevant aspects of introductory accounting content was made. The purpose here was to provide a reader who might not be very familiar with accounting with some insight into cognitive demands that introductory accounting poses for students.

The chapter has provided an explanation of the difficulty accounting students experience when learning introductory accounting. This chapter described the instructional design issues discussed in the first chapter. The greater part of this chapter discussed the accounting cycle and the balance sheet focusing on the design of accounting instructional material. The final section broadly discussed the challenges accounting learners and academics face, specifically as they relate to accounting instructional design.

The key issues discussed highlight the need for a better understanding of the cognitive complexity of accounting material. This cognitive complexity contributes to the various challenges which academics and learners encounter. Not least among these challenges is that the instructional material is not optimally designed according to CLT principles. To better understand these principles, the next chapter explains how cognitive structures are organised and how humans process information during the learning process. In particular our modern understanding of human cognitive architecture is presented which will lead to a discussion of information structures and memory models as they relate to teaching and learning and the process of schema automation and construction. This discussion is essential since the subsequent chapter (Chapter 4) will present CLT's claims about how learning happens best under conditions that are aligned with human cognitive architecture.

Chapter 3: Human Cognitive Architecture

3.1 Introduction

This chapter discusses how cognitive structures are organised and how humans process information during the learning process. Initially, l present modern understanding of human cognitive architecture, largely based on the work of Atkinson and Shiffrin (1968), and analysed from a biological, evolutionary perspective (Geary, 2007, 2008). As a caveat, l am of course only writing about those aspects of human cognitive architecture that are salient to the topic addressed in the study. These include human cognitive architecture principles, three aspects related to memory (sensory memory, short-term memory and long-term memory), memory models, metacognition, and schema construction and schema automation. A brief explanation of why understanding cognitive processes is essential for learning is presented below.

The discussion in this chapter revolves around human memory. Memory is particularly important to educators due to the profound importance of memory for learning. Memory is often associated with the recall of lists of information, specific facts, dates and sets of instructions (Caine & Caine, 1997). The concept of memory goes far beyond this one-dimensional aspect of learning and is relevant to numerous areas; among them, learning, attending, remembering, linking, and using the thousands of pieces of skills and knowledge that we meet regularly (Banikowski & Mehring, 1999). For educational instructors, tests of memory is one way to produce evidence that something has been learned. Banikowski and Mehring (1999:1) aptly summarise the need to understand memory in an analogy given in a cartoon where two boys were talking. One boy, with his dog at his side, says, “I've taught my dog how to whistle,” and the other little boy says, “Great! Let me hear him whistle.” The first boy then says, “I said I taught him how to whistle. I didn't say he learned it!” Instructors have an important role to play in ensuring that students attach new learning to previous learning, attend to learning, construct meaning, actively engage in learning, and demonstrate their learning. All these

aspects require memory. Learners have to be capable of storing, organising, and retrieving skills and knowledge. By employing what we know about how the brain remembers and learns, instructors and students may be able to concentrate on the "learning" part of teaching.

3.2 A Review of Relevant Aspects of Human Cognitive Architecture as they Relate to Teaching and Learning

Human cognitive architecture is concerned with the organisation of cognitive structures such as working memory and long-term memory used to process information (Cowan, 2014; Sweller, 2012). Memory structures are fundamental to this architecture in terms of how students learn, think and solve problems. An essential attribute of human cognitive architecture is that it comprises a "powerful" long-term memory, which can hold an unlimited number of elements (schemas) on a relatively permanent basis and a limited working memory (Sweller, 2004). Working memory is defined as, "…the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension and learning" (Baddeley, 2010:136). The things contained in this system can be transformed to long-term memory (LTM) through the process of meaningful association and rehearsal. The long-term memory is facilitated by learning mechanisms such as schema development and automation (Sweller, 2008). Essentially, "working memory is where thinking occurs" (Moreno, 2010:202), where crucial cognitive processes occur. If information cannot be processed beyond working memory, no meaningful learning occurs.

3.2.1 Modal Model of Memory

Research into human memory has generated a number of models of how information is processed. The main features of human cognitive architecture were put forward by Atkinson and Shiffrin's 1968 "modal model", and Figure 3.1 presents an illustration of that modal model of human memory.

As shown in Figure 3.1, the modal model of information processing consists of sensory memory, working (short-term) memory and long-term memory. Working memory is generally used synonymously with short-term memory (Cowan, 2008).

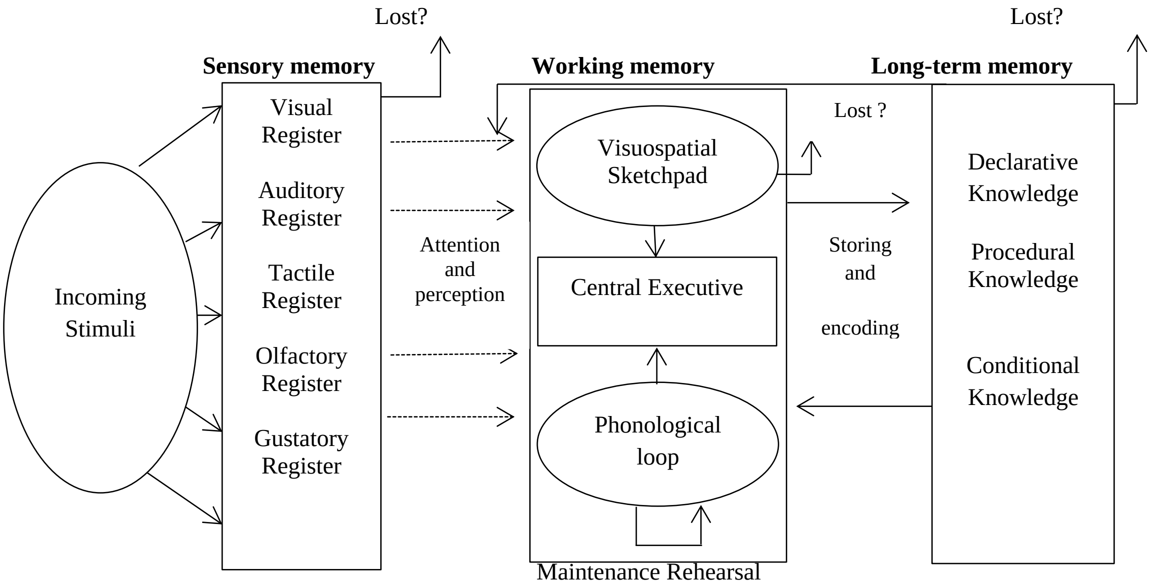


Figure 3.1: Cognitive processes and memory systems from an information processing framework.
Source: Moreno (2010:213)

Information drawn from the environment first enters the sensory memory, from which it enters working (short-term) memory. People retrieve information applicable to current tasks, and there is a limit to the amount of data they can process within any given time period. As illustrated in Figure 3.1 if rehearsal of information strategies is employed it allows for information to be stored more permanently in the long-term store. Atkinson and Shiffrin (1968) initially described rehearsal as maintenance rehearsal, but Shiffrin later suggested that rehearsal could be elaborative (Raaijmakers & Shiffrin, 2003).

Early works by Miller (1956) were fundamental to the development of the information processing framework and our understanding of memory. His seminal paper (p. 81), “The magical number seven, plus or minus two”, was pivotal to the development of our understanding of the limited capacity of short-term memory. Miller’s work focused on limits to the amount of information that can be held in short-term memory; in his

view, 7 plus or minus 2 chunks. These chunks are defined as independent items of information. Some chunks are perceived as one unit although they may be broken down into multiple items. For example “CAR” can be either the series of three letters “C, A, R” or the semantically grouped item “car.” However, a series of numbers, for example 13817203105 is eleven individual items well outside the limit of the short-term memory store. Similarly, an individual who meets a string of eleven letters may have difficulty remembering it twenty seconds later, because short-term memory cannot handle eleven continuous pieces of information. However, these fourteen letters (P OP CO RN IN AB OW L) may easily be remembered if they are grouped into four familiar words, POPCORN IN A BOWL.

3.2.2 Sensory Memory Storage, Processing and Capacity

As seen in Figure 3.1, memory comprises a set of registers relating to the human senses: auditory (hearing), visual (sight), tactile (touch), gustatory (taste), olfactory (smell). Sensory memory is the first structure that temporarily holds stimuli from the environment in detail but only for an instant until it can either be further processed or gets lost (Freedenberg & Gordon, 2010). The information which is stored in sensory memory is held just long enough to be transferred to short-term memory. This information cannot be retained in the sensory registers for long periods as it decays quickly. Therefore, sensory memory (SM) allows people to retain impressions of sensory information after the original stimulus has stopped. For example, if a light moved quickly in a circle inside a dark room, most people will see a light in the form of a circle instead of the discrete positions through which the light has moved. Such observations take place since the sensory memory holds the continuous images of the moving light long enough for the brain to see a circle. When processing information, sensory memory stimuli detected by human senses can be deliberately ignored and disappear instantaneously, or it can enter the human sensory memory. The process does not necessitate any deliberate concentration and is typically thought to be completely

outside of conscious control. In contrast to other types of memory, the sensory memory cannot be prolonged via rehearsal.

The sensory memory has a large capacity and probably can hold everything the body is capable of hearing, sensing or seeing (Cowan, 2005; Ormrod, 1998). Cowan (2005) contends that the idea of one's memory "filling up" is a misconception of how memory in general is thought to work. However, working memory has limited capacity (Cowan, 2014). Sensory memory has no capacity limit although the information stored in the sensory memory does not last long (Weiten, 2013). Some researchers have documented sensory registers as having durations of between 1 to 4 seconds. According to Henson and Ellen (1999), visual information lasts for approximately less than 1 second, and auditory information can last up to 4 seconds and tactile information between 2 and 3 seconds.

The capacities of the other sensory-memory stores have not yet been well studied because the memories of these last no more than a few seconds and are at the preconscious level. The amount of time the visual, auditory or tactile stimulus is maintained is usually sufficient for it to be recognised, classified, stored in working memory or ignored (Schoenfeld, 1987). In the absence of actively focussing attention to the information held in the sensory register, it is quickly lost. From the sensory memory, the information is transferred to working memory or short-term memory which makes it accessible for storage in LTM or for interaction with long-term memory components.

3.2.3 Short-term or Working Memory Storage and Processing Capacity

Short-term memory involves an accessible limited amount of information held temporarily in the faculties of the human mind (Cowan, 2008). The term "working memory" was popularised and became dominant after Baddeley and Hitch (1974) established that all kinds of temporary memory cannot be accounted for by a single module. Baddeley and Hitch's (1974) ideas led to an influential model in which visual-

spatial and verbal-phonological representations were held separately and were manipulated and managed with the assistance of attention-related processes called the central executive (Baddeley, 1986). This distinction is a key antecedent to understanding split-attention.

As Figure 3.1 shows, information enters short-term memory or working memory through sensory memory. Some of the information that enters short-term memory decays and is lost. However, the information in short-term memory has duration of nearly 18–20 seconds when the information is not being actively rehearsed. This also depends on the modality and may be as long as 30 seconds. Information may also be held in the short-term memory for longer periods of time through the process of rehearsal. In fact, short-term memory or working memory is where a wide variety of computations are performed (Cowan, 2014; Freedenberg & Gordon, 2010). Information is transferred into long-term memory and retrieved from long-term memory. This information then goes through a control process where some information is retained or lost through a response output via coding or rehearsal. If the information is retained it passes to long-term memory where it will be retrieved through a logical process. The process by which information is taken to long-term memory is called encoding. The amount of information that is processed is dependent on the complexity of the information and the amount of available mental resources.

In terms of storage, the key concept of chunking is that short-term memory, although probably subject to some constraints, is not rigid but responsive to strategies, such as chunking, that can expand its relative capacity (Miller, 1956). This view still exists today and remains relevant to working memory theories. Even though the idea of a “magical number” is still an element of modern thought concerning short-term memory capacity, most recent work has proposed that the number might not be seven plus or minus two, as Miller suggested, but instead may be much less, maybe 4 plus or minus one (Cowan, 2001; Cowan, Nugent, Elliot, Ponomarev, & Saults, 1999; Gilchrist,

Cowan, & Naveh-Benjamin, 2008). Cowan (2001) states that the reviewed approximation comes from a review of studies suggesting that storage capacity is much lower than seven when participants are prevented from using strategies such as chunking or rehearsal. The other view is that although capacity limits exist, they are entirely task-specific, with no way to establish a general estimate (Bunting, Cowan, & Saults, 2006; Cowan, 2001).

The recall limit is important in this research because it measures working memory. Working memory is used in mental tasks, such as comprehension where retaining information from earlier on in a sentence can be combined later with other ideas. The other area of application is problem-solving, for example in accounting where we carry a figure when summing columns.

The modal model of memory provides a basic summary of the memory functions. However, it was developed in the early stages of cognitive psychology and fails to specify some of the nuances of memory structure and functions. In fact one criticism to the Atkinson-Shiffrin's (1968) model is the assumption that the mere maintenance of material in short-term memory would guarantee long-term learning. According to Atkinson and Shiffrin's (1968) model, in the absence of an adequate short-term memory, information should be rapidly lost. Baddeley and Hitch (1974) attempted to address this by studying the consequences of disrupting short-term memory on the capacity of normal people to perform complex tasks such as comprehending, reasoning, and learning. Baddeley and Hitch (1974) argued that the modal model is a core system with two subsystems and not a unitary system (Alloway & Gathercole, 2008). This gave rise to the three-component working memory model as illustrated in Figure 3.2.

The model assumes three components: an attentional control system, the central executive (aided by two short-term storage systems, one for visual material, the visuo-spatial sketchpad, and one for verbal-acoustic material), and the phonological loop

(Baddeley, 2012). Information attained by the sensory memory moves into the central executive. This coordinates the sensory information, processing it into one of the two slave systems (Conway, Jarrold, Kane, Miyake, & Towse, 2007).

The phonological loop is the system responsible for the mental management of speech and audible information. The visuo-spatial sketchpad is the system in charge of visual images and their manipulation. Each component is independent, although both function as short-term storage centres. The two slave systems focus on processing temporary information from auditory and verbal domains. The bottom part of the diagram (Figure 3.2) represents long-term memory with permanent “crystallised” skills.

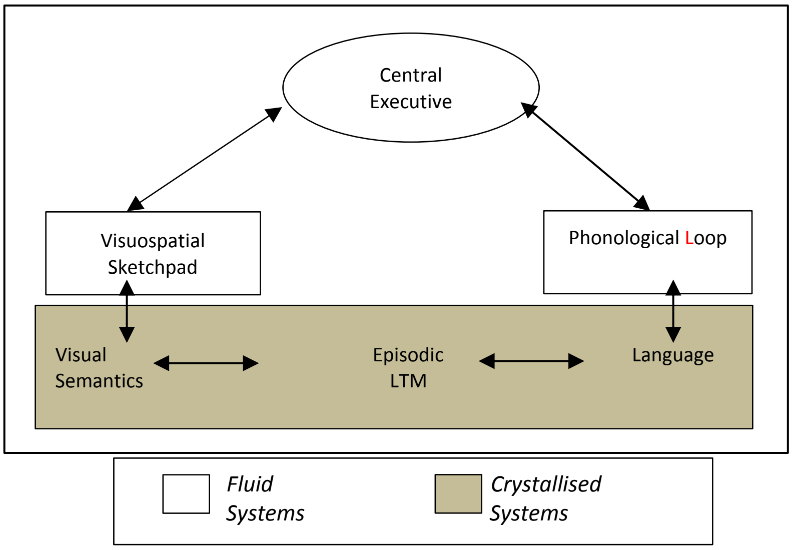


Figure 3.2: Baddeley’s model of working memory in 1996
Source: Baddeley (2012:11)

More recently, Baddeley (2000) revised his model to include a fourth component called episodic buffer (see Figure 3.3). This addition to the model is a separate limited capacity system that provides an interface between the two slave systems (the phonological loop and the visuo-spatial sketchpad) and long-term memory. As the name suggests, it is episodic in that it is assumed to hold integrated episodes or chunks in a multidimensional code (Baddeley, 2012). Episodic refers to the interface of complex

structures or episodes while the "buffer" specifies that the episodic buffer interacts with other perceptual and mnemonic systems (Rudner & Ronnberg, 2008).

This addition to the model provides an improved explanation of the more complicated aspects of executive function within working memory. There is more attention to the process of integrating information rather than the "isolation of subsystems" (Baddeley, 2000, p. 417). The episodic buffer performs an important part in passing information into episodic LTM and retrieving information from LTM (see Figure 3.3).

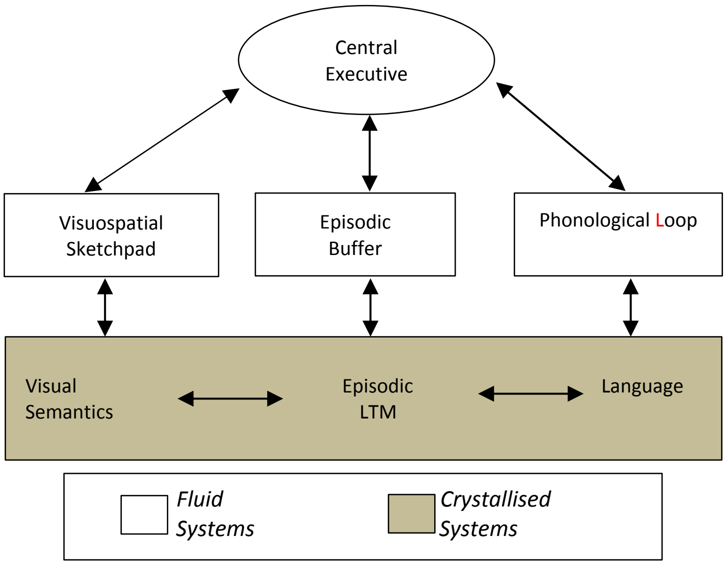


Figure 3.3: Baddeley's model of working memory in 2000
Source: Baddeley (2012:16)

There are several models of working memory. Atkinson and Shiffrin (1968) construed that information is activated via senses and then moves into short-term memory and long-term memory. Baddeley (1986, 2000) proposed the three component working memory model. Cowan (2005) viewed working memory as part of long-term memory. Although there are several models of working memory, they all agree that:

- working memory capacity is limited, thus constraining cognitive performance (Cowan, 2001, 2014; Miller, 1956; Simon, 1974) and

- there are limits in working memory duration (Russell, 2012). For example information can be held for 15-20 seconds (Moreno, 2010).

In summary, the limits in capacity and duration in working memory mean that if information is not encoded into a permanent form, it will decay from working memory and will be lost or forgotten (Russell, 2012). Alternatively the information might be replaced by incoming information that is competing for the limited memory capacity. Therefore, the rate with which long-term memory stores information is influenced by the extent to which working memory can accommodate information. The greater the working memory capacity, in relation to specific stimuli, the faster the speed at which material is learned. In addition, revision and rehearsal strategies are essential if information to be learned is to be transferred to long-term memory. For example, one might maintain a phone number in short-term memory by simple rehearsal of the number. The phone number must periodically be rehearsed or repeated. This can either be by saying it out loud or by mentally simulating such uttering. In this way, the phone number will be remembered. Humans show minimal or no deficits in short-term memory and can typically hold about 7 ± 2 digits in mind as long as the digits are being rehearsed.

Instructors want learners to access, organise, store, and retrieve knowledge and skills (Banikowski & Mehring, 1999). When instructional materials compel the student to process information that is likely to exceed the student’s limited working-memory capacity, the cognitive load imposed by such materials is unduly high, and a negative effect on learning is likely to occur (Morrison et al., 2014; Sweller, 1993). That is a highly relevant conceptual point for this study.

3.2.4 Long-term Memory (LTM) Storage, Processing and Capacity

The third part of the modal model is the LTM. LTM is a repository of permanent information and skills (Kirschner, 2002) which is thought to be highly structured

(Sweller, 2008). Once information is in long-term memory it may not be used immediately (Freedenberg & Gordon, 2010). The information would be in a state of storage and may sit there for a very long time. When information that resides in long-term memory is needed, a retrieval process takes place. In the modal model, information is retrieved from long-term memory into short-term memory where it can be worked upon. LTM allows individuals to recognise familiar faces, recall a birth date, drive a car, play tennis and write an email (Baddeley, 2012; Moreno, 2010).

Unlike working memory or sensory buffer, LTM seems to have limitless storage capacity for organised information. Our understanding of LTM has evolved over time. Initially it was understood to be a passive store of separate pieces of information that allows a repetition of what has been learned. Instead, LTM is now seen as a relatively large permanent store of past information that has been processed for meaning. It is the central structure of human cognitive architecture (Kirschner, Sweller, & Clark, 2006). Long-term memory (LTM) consists of self-regulatory knowledge, declarative knowledge and procedural knowledge. Self-regulatory knowledge refers to knowledge individuals have about themselves as learners, what they know, and how to control their learning while declarative knowledge relate to facts and concepts and procedural knowledge refers to how to do things, (Alexander & Winne, 2006). These three types of knowledge will be discussed below.

Declarative knowledge is a term that broadly categorises concepts, facts and the connections between concepts that lead to an integrated conceptual understanding of a specific area. The term declarative knowledge comprises thousands of facts such as the names of cars, numbers, colours, and trees. Concepts consist of two or more units of factual information that are used to understand a broader phenomenon such as social justice. Often concepts are phenomena that can be described abstractly, such as freedom or happiness, even though these phenomena do not exist in the physical world.

Declarative knowledge also includes integrated conceptual knowledge that is sometimes referred to as structural knowledge or mental models (Halpern, 2003).

Procedural knowledge on the other hand is knowledge about how to do things (Bruning, Schraw, & Norby, 2011) ranging from simple action sequences such as eating, to complex actions such as driving a vehicle. Most adults possess a vast amount of procedural knowledge, which enables them to perform complex activities such as easily shopping in a supermarket because those procedures are automated though practice.

Finally, within LTM, self-regulatory knowledge is knowledge about how to regulate one's memory, thought, and learning (Schunk & Zimmerman, 2006). Declarative and procedural knowledge alone are not sufficient to be an adaptive learner. In addition, individuals must possess knowledge about themselves as learners and about the skills they need to learn effectively. Self-regulatory knowledge can be divided into two types. There is domain specific knowledge and domain general knowledge (Alexander, 2003). Domain specific knowledge relates to knowledge specific to domains such as accounting or a sub-domain such as auditing. In contrast, domain general knowledge comprises general knowledge such as learning strategies that enable people to adapt and self-regulate across all domains.

All three types of knowledge (self-regulatory knowledge, procedural knowledge, and declarative knowledge) are important since even with a large amount of declarative and procedural knowledge, without self-regulatory knowledge to support it, people will not be able to survive and adapt successfully (Zeidner, Boekaerts, & Pintrich, 2000). On the other hand, any skill being learned starts out with declarative knowledge. For example, when learning to play tennis, one learns the rules of the game. Putting the facts into practice helps an individual to gain the skills to transform a series of declarative knowledge into procedural knowledge. The skills acquired could not be learned simply by being told as they require active practice and perhaps monitoring by a coach who

constantly provides feedback. The use of procedural and declarative knowledge forms together improves education (Willingham, Nissen, & Bullemer, 1989).

In summary, unlike working memory, in LTM it is not critical to rehearse items. Recalling of items in LTM depends on the understanding of what is being asked and how to access it. LTM has the following properties: it is virtually unlimited, durations last for a lifetime, and the processing of information is linked and organised according to meaning.

3.2.5 Schema Construction, Automation and the Learning Process

Schema refer to organised patterns of information or behaviour that structure categories of information and the relationships among them about some distinct domain (Alexander & Winne, 2006). It consists of knowledge structures held in long-term memory and can be referred to as schemas or schemata (Kalyuga, 2006). Schemas are preconceived ideas or a framework representing some aspect of the world. One of their functions is to provide a mechanism for knowledge organization and storage.

Alexander & Winne (2006) state that schemas are essential to learning for a variety of reasons. They enable learners to organise a large amount of data into an integrated body of knowledge in an efficient manner. They are useful in problem-solving due to the ability to access relevant information required to solve problems. Schemas are constructs that exist in a hierarchical order. For example there are lower order schemas (letters of the alphabet) which are incorporated into middle order schema (words) and these are combined into higher order schemas (phrases or sentences). Therefore these structures allow us to consider multiple elements as a single element, and constitute the cognitive structures that form the knowledge base (Sweller, 1988). Secondly, schema reduce the effort needed to encode and retrieve information due to organizational efficiency (Sweller, Van Merriënboer, & Paas, 1998).

Schemas vary considerably between novices and experts. An expert retrieves higher order schemas that can be utilised to solve complex problems. A novice does not have access to such higher order schemas and needs to process and develop ideas that might fit within their established schemas (Sweller, 1999). Learning would require a change in the schematic structures. It is demonstrated by a change in performance which progresses from slow, clumsy, difficult and error prone to smooth and effortless. The transformation happens since the individual becomes gradually aware of the learning material and the cognitive features related to it are changed to the extent that it can be handled more effectively by working memory. Paas, Tuovinen, Tabbers and Van Gerven (2003) contend that the main goal of teaching is the construction and automation of schemas.

The change in our understanding of the critical function that schemas serve in learning began with the work of De Groot (1965). De Groot conducted a number of experiments examining chess players ranging from novice (amateur) to expert (chess masters). He found that chess masters were successful because they had accumulated more chessboard configurations (patterns) into their LTM than the less able players and were able to draw on these schemas. De Groot established that chess masters do not have to work out the best move because they know the best move based on their extensive knowledge which was gained from thousands of board configurations played from real games throughout their experience (Kirschner et al., 2006).

Subsequent research by Chase and Simon (1973) replicated De Groot's (1965) work on chess expertise, but also tested memory using random chess configurations. The random configurations were used to test if there still existed a difference between novice and expert players. Expert players showed superior memory from configurations taken from real chess games, but there was no significant difference between novice and experts when the board configurations were random. They concluded that expert players used their extensive store of domain specific knowledge to make a chess move, while novice

players did not have such experience and knowledge. Novices had limited schemas and therefore could only rely on working memory to assist in the decision of what might be a good chess move. The investigation of novice and expert chess players implies that problem-solving skill is domain specific. For example, a mathematician has attained mathematical problem-solving skills that are not likely to transfer to accounting or personal relationship skills.

Schema automation is the ability to process information with minimal conscious working memory in so doing freeing working memory resources (Sweller, 2003). Schemas develop into automated structures after extensive practice, and schemas differ in their extent of automation (Van Merriënboer & Sweller, 2005). As Sweller et al. (1998) described, “with automation, familiar tasks are performed accurately and fluidly, whereas unfamiliar tasks—that partially require the automated processes—can be learned with maximum efficiency because maximum working memory capacity is available” (p. 258). In the absence of schema automation, a previously met task may be accomplished, but maybe through a slow and awkward process (Sweller et al., 1998). In addition, novel tasks may be difficult to complete unless prerequisite skills have been automated because not enough working memory capacity will be available for learning (Van Merriënboer & Sweller, 2005).

Schema acquisition and schema automation are two of the most significant considerations in understanding and learning. Schema automation provides us with the structure for LTM; and, in addition, permits us to smoothly process information about the world around us through the limited working memory (Chinnappan & Chandler, 2010). From a cognitive load theory perspective this cognitive architecture determines which instructional activities are probably efficient (Hasler, Kersten, & Sweller, 2007), and effective schema construction and automation are the main objectives for designing instructional materials. The examples of automation include activities such as adults reading a book or driving a vehicle. Automation is a result of direct instruction,

repetition and deliberate practice (Kalyuga et al., 2003). Automated schemas benefit learners in a number of ways: they provide a method of transfer; they require very little cognitive resources; and, they allow for extra cognitive resources to be used for learning. Transfer involves applying what was learned during instruction to a novel situation (Mayer & Wittrock, 1996). In order for transfer to occur, learners must not simply memorise or apply a fixed set of procedures (Bransford, Brown, & Cocking, 2000). Learners have to understand a concept or have command of a skill in order to be able to use it themselves. They must know how to relate what they have studied to different problems or situations, and they must know when it applies.

3.2.6 The Distinction Between Novices and Experts

In most given subject areas, the distinction relating to an expert and a novice often comes down to differences in the level of automation and schema expansiveness (Errey, Ginns, & Pitts, 2006). The two components of schema construction and automation seem to describe expert-novice differentiations. For any given situation, experts are simply working through their routine exercises. The more their expertise in one specific area, the larger their working memory capacity in that area. Thus, as illustrated earlier, chess players can maintain details of chess games played consecutively even when blindfolded (Saariluoma, 1995), and followers of football can remember goals from matches more accurately than casual fans (Morris, Tweedy, & Gruneberg, 1985). Possession of expertise permits well-organised retrieval and coding of information within the specific discipline. While memory skills depend on the working memory, individuals with expert knowledge significantly benefit from activating appropriate information stored in memory. The knowledge retrieved provides important assistance for the limited working memory.

In contrast, novices possess comparatively few schemas. Such a situation causes them to know only common and basic circumstances from which they can draw upon previous occurrences. Every time novices meet a content area, they must solve a problem, and

when they comprehend the correct response, they are more likely to have difficulties executing the appropriate reaction. In relation to the novice-expert discussion, the way learning materials are presented for less knowledgeable learners can have major consequences for the educational outcomes as the experiments reported in this study will show (Cooper, 1998).

The review presented in this section suggests schema acquisition and automation are essential cognitive processes for enabling the transfer of problem-solving skills (Cooper & Sweller, 1987; Jelsma, Van Merriënboer, & Bijlstra, 1990; Van Merriënboer & Paas, 1990). Within a conventional instruction setting, transfer is frequently near, limited to problems that are highly similar to the ones used during instruction (Paas, 1992). This thesis investigates a non-conventional strategy of self-management in order to establish whether learning is enhanced by more effective transfer to unfamiliar aspects of problems for novice learners.

3.2.7 Extension of our Understanding About Human Cognitive Architecture

Several developments over the past decade are extending our understanding of human cognitive architecture by linking the information processing model with modern evolutionary theory (Sweller, 2006, 2010). The premise of the recent work is that through evolution humans have evolved to perform a range of cognitive activities that vary in complexity and have differing levels of cognitive consequences (Sweller, 2006, 2010; Sweller, Ayres & Kalyuga, 2011).

This theoretical framework differentiates primary and secondary biological knowledge (Geary, 2008). The biologically primary knowledge relates to knowledge that is readily learned, frequently without conscious thought. Outside of educational contexts we acquire huge amounts of information without explicit instruction; for example, recognising faces or a baby learning to walk. By immersing ourselves in a

listening/speaking society we unconsciously, effortlessly and rapidly learn to breathe, arrange our lips, tongue, and voices to enable us to speak (Sweller et al., 2011).

Biologically secondary information normally encompasses things that are taught in educational institutions. When attending to biologically secondary knowledge human beings have neither the motivational impetus nor the genetically inspired ability to assimilate information automatically (Sweller, 2008). Human beings would require explicit instruction and motivational encouragement which is not required when dealing with biologically primary knowledge.

Human cognition can be characterised by five principles that explain the functions and processes a learner engages in to acquire biologically secondary knowledge (Sweller, 2010; Sweller et al., 2011). The five principles are presented below.

- **Information store principle.** Relates to the requirement for long-term memory to store a huge amount of information that directs activity. LTM is now no longer seen as a source of unrelated, isolated facts that are regularly stored and retrieved. LTM is seen as a central structure of human cognitive architecture.
- **Borrowing and reorganising principle**. Refers to the accumulation of information by borrowing and reorganising it from other sources. The main function is to ensure that knowledge is not lost. For humans information in LTM is organised as schema, and this information has been "borrowed" by sharing the schemas from LTM stores of others through listening to what people say or reading what people write.
- **Randomness as genesis principle**. Refers to the formation of knowledge. The requirement to transfer knowledge should not conceal the fact that knowledge must first be created in order to be transfered. An example is found in problem-solving when a learner comes to a "dead end" and has to revise the steps using knowledge stored in LTM and needs to continue the process of random generation and tests until the solution is found.

- **The narrow limits of change**. Refers to the fact that there are limits when creating knowledge. Only small changes to the amounts of new information can be dealt with by the human cognitive architecture. Changes to the LTM occur incrementally and over long periods of time.
- **Environment organizing and linking principle.** Refers to the usefulness of information available within our environment. When human beings encounter recognisable material which is presently well structured in our LTM, there is no practical reason for a limited working memory. Therefore huge amounts of prearranged information may be retrieved from LTM to working memory without overburdening working memory to respond in a given environment (Ericsson & Kintsch, 1995; Sweller et al., 2011).

Sweller (2006; 2008; 2010) emphasised that the degree to which educational material is effective is determined by whether it takes the human cognitive architecture into account. Given that most of what is learned in universities and schools is biologically secondary information, it is subject to the constraints and limits of human memory structures and processes. This thesis deals with biologically secondary knowledge for which cognitive architecture plays a pivotal role in learning.

3.3 Chapter Summary

This chapter examined the structures and processes of human cognitive architecture which comprise the guiding framework for CLT, the focus of the current thesis. The main mechanisms of the human cognitive system, sensory memory, working memory and long-term memory, were discussed. This chapter concluded with a discussion of the latest developments in human cognitive architecture from an evolutionary perspective. Biologically primary and secondary knowledge emanating from this perspective were explained, and a consideration of five principles which facilitated acquisition of biologically secondary knowledge followed.

This chapter's presentation of our modern understanding of human cognitive architecture is essential since the next chapter (Chapter 4) presents CLT. CLT proposes that acquisition of knowledge occurs best under situations that are in alignment with human cognitive architecture**.** One of the goals of instruction is to facilitate the storage of information in LTM. Attainment of properly organised information in LTM is a major consideration of CLT and is discussed in the next chapter.

Chapter 4: Cognitive Load Theory and a Review of Relevant Literature

4.1 Introduction

The previous chapter presented theoretical and empirical arguments to support the idea that instructional procedures that take into account human cognitive architecture are likely to be more effective. This view of cognitive architecture is used as the basis for cognitive load theory (Sweller, 2015; Sweller et al., 2011), as discussed in this chapter. A detailed explanation of CLT and how cognitive load is measured is provided followed by the instructional implications of the theory. This provides a theoretical rationale for the research reported in this study. Emphasis is given to the split-attention effect as it is the most relevant cognitive load effect examined in this study. The chapter concludes with a discussion of the criticisms and challenges of CLT.

The basic tenet of CLT is that humans face cognitive resource constraints during learning and problem-solving. This occurs because human cognitive architecture, in particular the relationship between working memory (WM) and long-term memory (LTM), largely determines learning efficiency in a context of resource constraints (Ayres & Paas, 2009). Thus CLT represents a model of instructional design where the processing constraints of WM are used to explain differences in student learning. CLT asserts that learning is compromised when working memory capacity is exceeded. Modifying conventional instructional procedures to accommodate the insights from CLT may yield efficiencies in training with less mental effort required to achieve the same level of transfer and learning (Paas et al., 2003).

4.2 Origins and Development of Cognitive Load Theory

CLT was developed at the beginning of the 1980s. It is based on more than 30 years of experimental research (examples of empirical work include: Chandler & Sweller, 1991;

Cooper & Sweller, 1987; Kalyuga, Chandler, & Sweller, 2000; Moreno, 2006; Paas, 1992; Sweller & Chandler 1994; Tindal-Ford, Chandler & Sweller, 1997; Van Merriënboer & Ayres, 2005; Van Gog & Paas, 2008). CLT emphasizes working memory constraints as a major determinant of instructional design effectiveness. These limitations of working memory are well-known and widely accepted (Paas, Renkl & Sweller, 2003; Sweller, Van Merriënboer & Paas, 1998). CLT had been used to generate instructional techniques with experiments carried out in most continents of the world (Paas, Renkl, & Sweller, 2003).

Having developed a diverse range of basic instructional designs, a growing number of cognitive load theorists globally continued to consider how the instructional designs interrelated, first, with the features of the tasks and information that students were encountering; and, second, with the types of the students themselves (Van Merriënboer & Sweller, 2005). Interestingly, this focus of investigation has generated instructional guidelines that take into account how CLT has dealt with differences in information difficulty and with the knowledge level of students.

In complex learning environments, numerous interrelating knowledge structures must be managed concurrently in working memory in order for learning to occur. Generally, there is no benefit in decreasing extraneous cognitive load for learning materials with low element interactivity, because there will be sufficient cognitive resources available for learning. Decreasing extraneous cognitive load is essential for learning materials with high element interactivity, to free processing resources that can be devoted subsequently to learning (Carlson et al., 2003; Marcus, Cooper, & Sweller, 1996; Sweller & Chandler, 1994; Tindall-Ford et al., 1997). Blayney, Kalyuga, & Sweller (2015) demonstrated that in situations where high levels of element interactivity exceed cognitive capacity of students, at first giving complex learning material as a set of isolated elements of information that can be processed serially, rather than simultaneously, may reduce the cognitive overload. Students in accounting were obliged

to deal with difficult composite accounting problems, or as separated parts, involving breaking down the parts. Blayney et al.'s (2015) results showed that in dealing with high rather than low element interactivity, separated components were beneficial for novices. The interacting elements were more appropriate for students with more knowledge of the area. When deciding the format of instructional presentations Blayney et al (2015) contend that separating elements from a complex problem should consider the expertise of the learner.

In Pollock, Chandler and Sweller's (2002) experiments, a mixed instructional method (isolated elements followed by interacting elements instruction) was superior to the conventional method (interacting elements instruction during both stages) for novice learners. With regards to learner knowledge levels, Pollock et al. (2002) did not find any benefits of initially using simplified learning tasks compared to employing complex learning materials throughout the various stages for learners with higher levels of previous knowledge in the area. This effect, referred to as the partial element interactivity effect, will also be discussed in greater detail in section 4.5.1.

Cognitive load has three distinct parts (Sweller, 1994), intrinsic, extraneous and germane loads. Germane and intrinsic are productive forms of cognitive load while extraneous load is considered unproductive and does not relate to learning (Kalyuga, Renkl, & Paas, 2010). Each of the three types is discussed below.

4.2.1 lntrinsic Cognitive Load

Intrinsic cognitive load relates to the difficulty of a task in relation to the learner. The term intrinsic cognitive load is used because the demands on working memory capacity necessitated by element interactivity are intrinsic to the instructional material being learned (Paas, Renkl, & Sweller, 2003). The driver of intrinsic cognitive load is element interactivity in that a particular task's level of interacting elements determines the level of intrinsic cognitive load (Blayney et al., 2015; Sweller, 2010). An element refers to

something that needs to be learned, such as a procedure or concept. Low element interactivity instructional materials allow distinct elements to be learned with minimal reference to other elements and consequently imposes a low working memory load (Sweller, 2010).

Simpler learning tasks that omit selected interacting elements can be chosen to reduce intrinsic cognitive load, but the omission of vital, interacting pieces of information may compromise sophisticated understanding. Eventually, the simultaneous processing of all necessary components must happen in order for understanding to commence (Paas, Renkl, & Sweller, 2003). Learning to memorise elements in the basic accounting equation (A=L+E) is a task that will impose a low intrinsic load because it is low in complexity. This is an example of a task in introductory accounting which has low element interactivity (Blayney et al., 2015; Sweller & Chandler, 1994). However, applying the same equation (A=L+E) to a new accounting problem would require the learner to relate and compare parts of the formula with the other learning aspects in the problem. Such types of tasks are high in intrinsic load. The high intrinsic load can often be lessened by splitting tasks into manageable parts (Pollock et al., 2002).

In mathematics, some learning activities need intense cognitive load while others contain less cognitive load (Chinnappan & Chandler, 2010). When learning a learning assignment surpasses the mental resources accessible in working memory, cognitive overload arises. Chinnappan and Chandler (2010) also state that the degree of element interactivity and the intrinsic load is also dependent on the level of the student. A low intrinsic learning task for a mathematics instructor may be a heavy intrinsic load for students. Teachers have to consider intrinsic load from the student’s cognitive position. Certain instructional material may need to be broken down into smaller tasks in order to manipulate the intrinsic load (Mayer & Chandler, 2001).

4.2.2 Extraneous Load

The load that interferes and is unnecessary to schema acquisition and automation is known as ineffective or extraneous cognitive load (Paas, Renkl, & Sweller, 2003). In contrast to intrinsic load, extraneous load is created by the way in which information is accessible to students and can somewhat be influenced by designers of learning material. Instructional designers can manipulate and modify extraneous load by changing the instructions provided to the learner (Sweller & Chandler, 1994). Reduction of extraneous load is the main focus of this study.

Many conventional instructional materials are presented in a way that imposes extraneous cognitive load because they were developed without enough consideration of the structure of information or cognitive architecture (Morrison et al., 2014; Paas, Renkl, & Sweller, 2003). Any instructional material that imposes unnecessarily heavy extraneous cognitive load will require that working memory resources be used for activities that are irrelevant and thus will impede schema acquisition and automation.

High extraneous load also results when the learners are required to integrate a text and a diagram from two separate sources of information. The concept of extraneous cognitive load was introduced by Chandler and Sweller (1991) in a seminal paper that examined the results of six experiments most of which examined the split-attention effect (see Figure 4.1). In order to understand the information presented in Figure 4.1 below sections of the text need to relate to the matching entities in the diagram. To understand the text and diagram, the student has to hold the text in working memory while searching the diagram for the main switch representation (Chandler & Sweller, 1991). The search and match process required to integrate both sources of information needs to be completed before meaningful learning of the actual content can proceed. If the same instructional materials are redesigned to integrate text and diagram by placing the appropriate text as close as possible to the appropriate parts of the diagram (see Figure 4.2), then learning may be enhanced since less working memory resources are required

(Van Merriënboer & Ayres, 2005). The physical integration of text and diagram is thus important to effective instructional design.

Test:	To test insulation resistance from conductors to earth
How conducted:	i) Disconnect appliances and busways during these tests. Make sure main switch is "on" and all fuses are "in" Remove main switch from neutral bar and set meter to read insulation. Connect one lead to earth wire at MEN bar and take first measure by connecting the lead to the neutral. ii) If resistance is not high enough in either of the two tests in i) then measure each circuit separately.

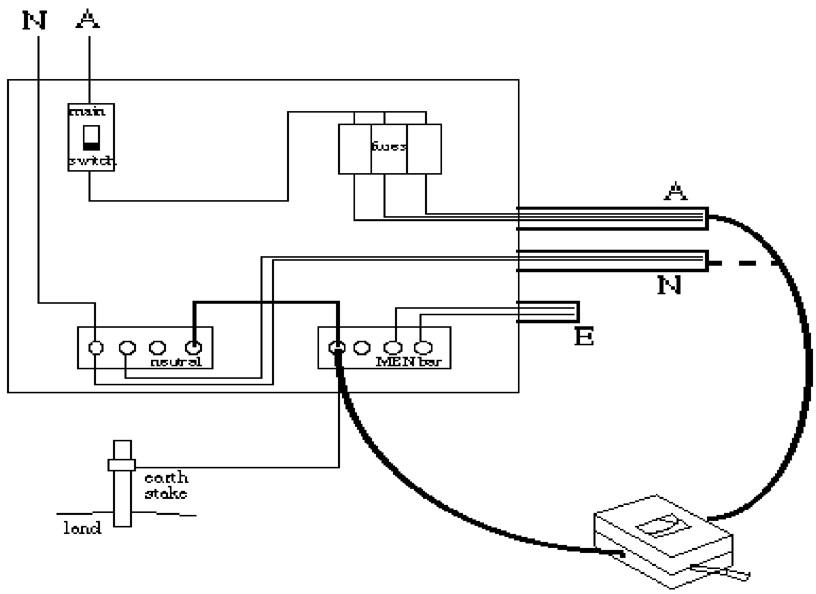


Figure 4.1: Split-attention instructions on a test of electrical resistance for installation testing
Source: Chandler & Sweller (1991:299)

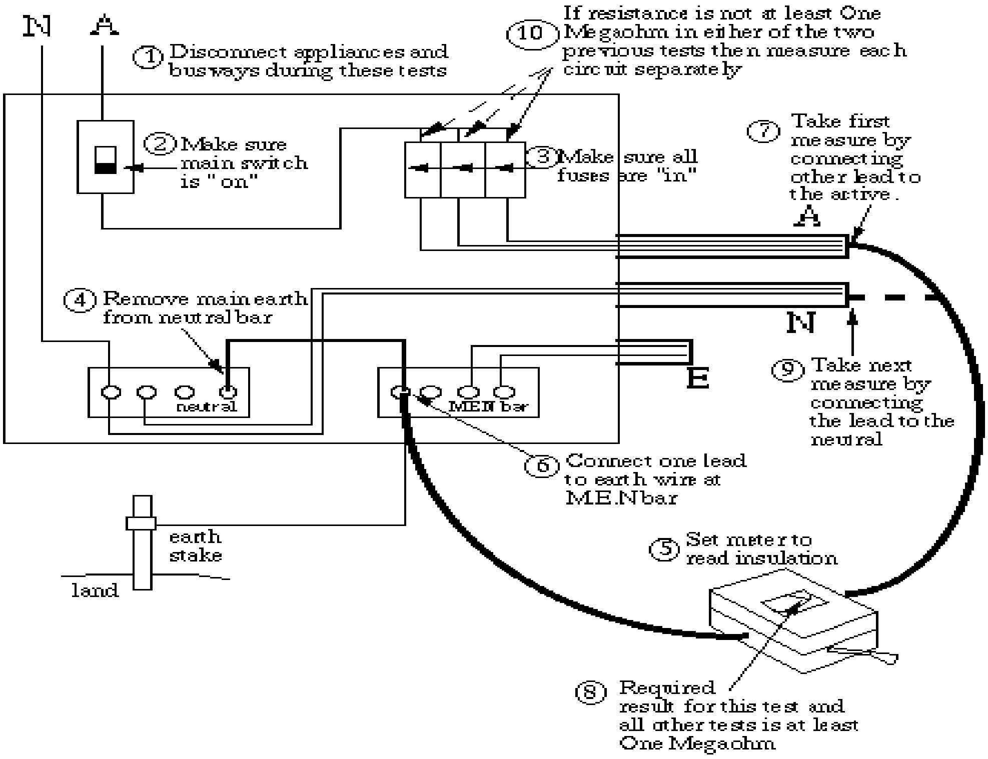


Figure 4.2: Integrated instructions on a test of electrical resistance for installation testing

Source: Chandler & Sweller (1991:300)

4.2.3 Germane Load

Actions that contain cognitive load and effort directly contributing and relating to schema automation and development are referred to as germane load (Chinnappan & Chandler, 2010). This is the load dedicated to the construction, automation and processing of schemas (Sweller, Van Merriënboer & Paas, 1998). Germane load was first described by Sweller, Van Merriënboer and Paas in 1998. Studies suggest that instructional designers can manipulate germane load by limiting extraneous load (Sweller, Van Merriënboer & Paas, 1998). Until 1998, CLT was mostly concerned with decreasing extraneous cognitive load. Beginning with Sweller et al. (1998), cognitive load researchers began to search for ways of redesigning learning instructional material to redirect extraneous load so that it becomes focused directly on learning.

The three types of cognitive load: extraneous, germane and intrinsic are not isolated; rather, they act as additive components. The combination of the three loads cannot go above an individual's available cognitive capacity. Once intrinsic cognitive load is high, it is essential to ensure that extraneous cognitive load is decreased; otherwise, the combined effect of the three may exceed the limit of cognitive capacity and thus impede learning (Paas et al., 2003).

According to CLT, instructional designers should be aware of all the three types of cognitive load and how they relate to each other. This will ensure that learners efficiently use their limited cognitive processing capacity to apply acquired knowledge and skills to new situations (i.e., transfer). This study investigates the ability of instructional format to reduce extraneous cognitive load and to thus increase knowledge transfer in learning accounting.

4.2.4 Measuring Cognitive Load

Paas (1992) indicates that cognitive load is a multidimensional concept with two essential components that can be distinguished, mental effort and mental load. *Mental load* is a result of instructional parameters such as sequence of information or task structure. *Mental effort* denotes the total amount of capacity allocated to instructional demands. Instructional changes that seek to manipulate and reduce mental load will only be effective if subjects actually invest mental effort and are motivated.

The question of how to measure cognitive load has proven difficult for researchers for a number of years. From the CLT perspective, its measurement is useful in order to obtain a comprehensive assessment of the cognitive load dynamics during performance of a task and across periods of task performance. Brünken, Plass and Leutner (2003) state that there are various methods of assessing cognitive load, and they are classified along two dimensions, causal relation (direct or indirect) and objectivity (subjective or objective). Causal relationship categorises methods on the basis of the type of relation of

the phenomenon observed by the measure and the actual attribute of interest. This is commonly called "construct validity." Objectivity denotes whether the method uses subjective, self-reported data or objective observations of behaviour, physiological conditions, or performance. This study uses the subjective self-reported measures which will be discussed below along with objective measures.

Buettner (2013) presented a method to measure cognitive load objectively on the basis of recording pupillary responses and eye movements using eye-tracking technology. Some researchers suggest other methods of measuring cognitive load. Deleeuw and Mayer (2008) assessed three frequently employed ways to measure cognitive load. They found that the methods responded differently to germane, extraneous and intrinsic load. Brünken, Plass and Leutner (2003) recommend using objective and direct methods for measuring cognitive load; for example, the use of neuroimaging techniques to measure brain activation during task execution (Smith & Jonides, 1997). This method is regularly used to visualize brain region activation in working memory studies that comprise very simple tasks, such as word sentence comprehension or memorization (Just, Carpenter, Keller, Emery, Zajac, & Thulborn, 2001). However, for complex learning processes, this method's reliability is not known (Braver, Cohen, Nystrom, Jonides, Smith, & Noll, 1997). The difficulty of using the device and the realistic real world restrictions of the duration and frequency of measurements make the use of this apparatus in educational settings problematic.

Another direct measure of cognitive load is the use of dual-task performance. Dual-task performance measurement involves asking participants to respond to a secondary task that is not related to the instructional material presented (for example recalling a number on a computer screen) while engaging in a primary task (for example studying accounting instructional material). A low performance in a secondary task would suggest that the primary task is high in cognitive load because there would be limited working memory resources left to perform a secondary task. A high performance in a

secondary task would suggest the primary task is low in cognitive load because there would be abundant working memory resources left to perform a secondary task (Sweller, 1988). Chandler and Sweller (1996) measured cognitive load of participants studying either split-attention (primary task) or integrated instructions (primary task). The participants were then asked to recall letters that appeared on a second computer screen. The results from the study showed that students studying under the split-attention condition did not perform as well as students studying integrated instructions on the secondary tasks. Chandler & Sweller (1996) concluded that the traditional split-attention instructions were higher in cognitive load demands than the integrated instructions. A series of studies have demonstrated the effectiveness of dual-task methods to measure cognitive load (Marcus et al., 1996; Brünken, Plass, & Leutner, 2004; DeLeeuw & Mayer, 2008). However, it has also been argued that dual tasks can be intrusive to learning (Paas, 1992). In addition, it is argued that secondary task measures may not be as sensitive unless they are delivered in the same modality as the primary task (as in Chandler & Sweller, 1996). These issues present limitations of the dual-task techniques in cognitive load measurement.

A self-reporting scale usually involves a questionnaire comprising a scale where participants may specify the cognitive load level experienced during a task. Participants are asked to assess how difficult or easy they found the instructional phase of a particular learning strategy (Ayres, 2006). Cognitive load can be assessed by measuring performance, mental load or mental effort using Paas and Van Merriënboer’s (1994) model. Overall efficiency ratings can be calculated by combining the performance on test items and their associated mental effort ratings. This self reporting scale and the relative condition efficiency procedures adopted in this thesis, will be shown and discussed in section 6.4.3.

Efficiency is a multidimensional concept. In learning, Paas and Van Merriënboer (1993) consider learning efficiency as measured by the relationship between performance output and mental effort invested. Paas and Van Merriënboer (1993), using worked examples, completion problems, and discovery practice utilised relative condition efficiency to compare three instructional conditions. Their results showed that learners who studied worked examples were the most efficient, followed by those who used the problem completion strategy. Since Paas and Van Merriënboer's (1993) study, numerous other studies have employed the relationship between performance output and mental effort invested to measure cognitive load in learning.

Criticism of this cognitive load measurement suggests that researchers need to exercise caution when using mental load scales (Van Gog & Paas, 2008). Although this metric is often used in most recent cognitive load studies (Paas, Tuovinen, Tabbers, & Van Gerven, 2003), the connection between the mental effort and actual cognitive load has not yet been fully explored since a low amount of mental effort could be as a result of low-cognitive load or, possibly, of such a high load that the student reduced the mental effort used on understanding the instructional material (Reed, Burton, & Kelly, 1985).

There have also been attempts to measure different types of cognitive load separately. Measuring the overall perceived cognitive load in relation to performance by subjective or objective techniques can provide useful information (Van Gog & Paas, 2008). However, some researchers have suggested that a measure of the different types of cognition is necessary (Ayres, 2006; Cierniak, Scheiter ,& Gerjets, 2009; Galy et al., 2012). A major challenge for these studies is that different types of cognitive load may be represented by a single item. Using multiple indicators for each of the distinct types of cognitive load might provide precise measurements and might enable separate types of cognitive load to be investigated rather than using a single indicator. In addition, any one specific instructional feature may be difficult to measure because an instructional

feature may be associated with germane cognitive load for one student and extraneous cognitive load for another student (Kalyuga et al., 2003; Kalyuga et al., 2001).

The most frequently used and promising cognitive load measure is the subjective, self-reported measures of mental load in terms of applicability and reliability (Paas, 1992). These self-reporting measures use a rating scale and require people to report the amount of mental effort used after they reflect on the cognitive resources they have used. Although self-ratings may be questionable, it has been established that people are able to give a numerical value reflecting their mental load (Gopher & Braune, 1984; Paas, 1992). Paas (1992) first demonstrated this observation in the context of CLT and claimed that a self-reporting scale is as effective as using more direct physiological measurements such as heart rate and pupil dilation that also seek to measure cognitive load. In several previous studies, the scale's (Paas, 1992) reliability (alpha > .8) and discriminate validity have been demonstrated (Gimino, 2000; Paas et al., 1994).

Currently, a feasible best known way to measure cognitive load is by combining the performance and mental effort measures. This has become an acceptable way to estimate cognitive load and to understand the relationship between instruction and mental load (Paas & Van Merriënboer, 1994; Paas & Van Merriënboer, 1993). It will be adopted in cognitive load measurement in the current thesis.

4.2.5 Instructional Condition Efficiency

This study uses Paas and Van Merriënboer's (1993) model to measure instructional design efficiency. This subjective measure has very high face validity, is nonintrusive, easy to obtain and easy to analyze (O'Donnel & Eggemeier, 1986). Even though a single measure of cognitive load can differentiate learning instructional conditions, a more significant understanding of the level of cognitive load can be specified in relation to the connected performance outcome. Instructional condition efficiency, a method

designed to combine performance and mental effort to compare the efficiency of instructional conditions has been developed (Paas & Van Merriënboer, 1993).

The method to measure instructional condition efficiency in the Paas and Van Merriënboer (1993) and Paas et al. (2003) investigations involved mental effort, measured on a 1 (lowest) – 9 (highest) scale, and student performance reported as percentages. First, each of the student scores for effort and performance was standardised by taking the total mean and subtracting from each score, dividing the result by the standard deviation, transforming it into a z-score for effort, R, and a z-score for performance, P, across conditions. Then, an instructional condition efficiency score, E, is computed for each student using the formula:

$$E = \frac{P - R}{\sqrt{2}}$$

The result is that the mean z-scores for every condition are denoted on a Cartesian coordinate system as shown in Figure 4.3. The Mental effort (*M*) z-scores are shown on the horizontal axis and Performance (*P*) z-scores on the vertical axis. A line (P = M) which goes through the origin shows a neutral efficiency (slope = 45°). On the Cartesian coordinate system, efficiency (E) is calculated as the perpendicular distance from a data point in the coordinate system to the line P = M (Paas & Van Merriënboer, 1993). Alternatively, the formula for calculating this distance as presented earlier is $E = (P - R)/\sqrt{2}$.

Kester, Kirschner and Van Merriënboer (2006) state that if performance (*P*) and effort (*R*) *z*-scores are equal ($P = R$) they yield an instructional efficiency of zero ($E = 0$), a neutral score. When performance z score is higher than the effort rating z score ($P > R$), the instructional material is more efficient, indicated by a positive value ($E > 0$) because the performance is higher than might be expected on the basis of perceived mental effort (for example when the data point is to the left of the diagonal line). When $P < R$, the material is less efficient, indicated by a negative value ($P < R$) because the performance

is lower than might be expected on the basis of perceived mental effort. As illustrated in Figure 4.3 that is when the data point is to the right of the diagonal line.

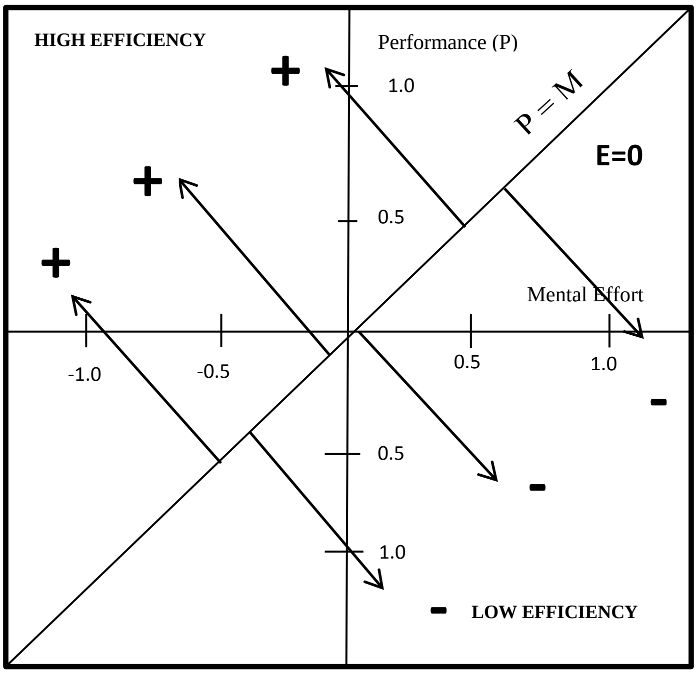


Figure 4.3: Efficiency measures in a Cartesian coordinate system
Source: Kester, Kirschner, & Van Merriënboer (2006)

The efficiency measures described here will be utilised in the current thesis.

4.3 Instructional Designs Generated by Cognitive Load Theory

As a result of CLT theorists' attention on theory application, numerous predictions concerning the way students learn have been made, and the predictions have led to various instructional design techniques. These techniques seek to keep extraneous cognitive load as low as possible during learning, and a number of instructional procedures that reduce working memory load for students have been reported in various studies (Chandler & Sweller, 1991; 1992; Paas, Van Gog, Sweller, 2010). The rationale is that the instructional procedures lead to instructional formats that focus on decreasing the load imposed by instructions (extraneous cognitive load) which frees working memory capacity for learning to occur.

Many studies have illustrated the superiority of instructional material designed with CLT principles in mind. Five of the most researched CLT-derived instructional effects are (a) expertise reversal effect (e.g., Blayney et al., 2010; Kalyuga et al., 2003); (b) the worked example effect (e.g., Kissane et al., 2008; Paas & Van Gog, 2006; Sweller, 2006); (c) the split-attention effect (e.g., Ayres & Sweller, 2005; Chandler & Sweller, 1991; Clark et al., 2006; Clark et al., 2006; Florax & Ploetzner, 2010); (d) the modality effect (e.g., Ginns, 2005; Goolkasian, Foos & Eaton, 2009; Mayer, 2001, 2005); and, (e) the redundancy effect (e.g., Moreno & Mayer, 2002; Samur, 2012). These effects have been revealed in numerous experiments conducted with a diverse range of instructional materials. Each CLT instructional effect will be discussed briefly below. The CLT instructional effect most relevant to the current study, the split-attention effect, will be discussed in more detail.

4.3.1 Expertise Reversal Effect

The expertise reversal effect has established the need to modify learning instruction based on levels of learner expertise (Kalyuga et al., 2003; Oksa, Kalyuga, & Chandler, 2010). Instructional techniques that are effective for novices can lose their effectiveness and even have a negative effect on experienced learners (Kalyuga, 2007). Kalyuga, Rikers, and Pass (2012) described expertise as the capability of a learner to perform fluently in a specific class of tasks.

Kalyuga et al. (2012) noted various studies that explain the expertise reversal effect and in particular explain why several counterintuitive phenomena are observed in studies of the relative performance of novices and experts. Medical studies have demonstrated that novice medical learners may perform better than expert medical practitioners on recall of specific cases. Kalyuga et al. (2012) further revealed that experienced technical trainees may benefit less from instructions that are effective for novices. Finally, novice players achieved better results in sports involving movement under the skill-focused category than expert players. In all these studies, there was an evident mechanism that

disturbed expert performance whilst enhancing the performance of novice individuals. This deterioration in experts' performance, with experts learning worse than expected, is referred to as the expertise reversal effect (Kalyuga et al., 2012).

4.3.2 Worked Example Effect

One of the first effects examined in CLT (Roodenrys et al., 2012), was the worked example effect. This refers to the learning effects detected when worked examples are used as part of instruction, when compared to other instructional techniques such as problem-solving (Renkl, 2005). Sweller (2006) argued that the worked example effect is the most widely studied and the best known of the cognitive load effects. Worked examples reveal a step-by-step process task demonstration to guide novice learners on how to solve a problem or how to perform a task (Clark et al., 2006).

	$e\,(a + b)$	$= g$
divide both sides by *e*	$e\,(a + b)/e$	$= g/e$
cancel out *e* top and bottom	$a + b$	$= g/e$
subtract *b* from both sides	$a + b\ \underline{-\ b}$	$= g/e\ \underline{-\ b}$
cancel out +*b* with –*b*	a	$= g/e - b$

Figure 4.4: Worked example involving geometry
Source: Cooper & Sweller (1987:360)

Figure 4.4 shows a worked example for an algebraic equation where the learner is required to study the step-by-step process to find the solution and then try to solve a similar problem using the procedural skill and conceptual understanding just acquired. Studying worked examples prevents the use of weak problem-solving strategies such as means-end analysis, by presenting the learner with the givens and a goal statement as well as a worked-out solution with steps that are to be taken to reach the goal state. The novice learner can devote all available cognitive resources to studying the given solution and constructing a cognitive schema for solving such problems.

Research in CLT has demonstrated that the study of worked examples is a more effective alternative than problem-solving (Kissane et al., 2008; Paas & Van Gog, 2006; Sweller, 2006). Sweller and Cooper (1985) demonstrated the effectiveness of worked examples over solving problems using algebra transformation problems. However, recent studies have also reported that worked examples could be suitable for less knowledgeable learners and not expert students (Kalyaga et al., 2001; Renkl, 2005). As students study, they gather more knowledge and they become experts, and under these situations worked examples must be substituted with problem-solving exercises.

Worked examples, unlike conventional problem-solving, do not require extensive use of search techniques which have been found to present an overload on memory capabilities. Conventional problem-solving presents an unguided alternative where the burden is on the learner to discover the best path to a solution. An extensive body of research has discussed the benefit of worked examples as opposed to conventional problem-solving. A worked example to a problem helps novice learners develop problem-solving schema (Clark et al., 2006; Cooper & Sweller, 1987; Owens & Sweller, 2008; Paas, 1992; Paas & Van Gog, 2006; Paas & Van Merriënboer, 1994).

It is important to ensure that worked examples are carefully structured so that unnecessary cognitive load does not impact negatively on learners (Cooper & Sweller, 1987; Sweller & Cooper, 1985). Tarmizi and Sweller (1988) demonstrated the worked example effect using circle geometry problems. However, it was shown that for worked examples to be effective, their format had to be substantially altered in order to reduce cognitive load. Chandler and Sweller (1992) suggested that an effective way to structure worked examples was the integration of text and diagrams (within worked examples) thus eliminating the split-attention effect. Worked examples that require students to split their attention between multiple sources of information and mentally integrate those multiple sources were ineffective.

But when learners possess a knowledge base adequate for understanding, the use of worked examples may have negative effects (Kissane et al., 2008). With increasing expertise, the load imposed by the task becomes lower, and, as a result, extraneous load might no longer have negative effects because enough cognitive capacity would be available to deal with the task. Kalyuga, Chandler, Tuovinen and Sweller (2001) demonstrated that for advanced learners, with prior knowledge on the subject, studying worked examples is a redundant, unnecessary cognitive activity. For experts, worked examples are likely to be ineffective or may even hinder learning (the creation of an expert reversal effect).

4.3.3 The Modality Effect

The modality principle emphasises that people learn better from graphics (such as charts, illustrations, photos, video or animation) and words (such as printed text or spoken text) than from words alone (Ginns, 2005; Mayer, 2001, 2005, 2009; Sweller, 1999). Visual and audio sources of related information seem to complement each other for enhanced understanding. Thus, it is suggested that graphics should not be associated with concurrent on-screen text but with concurrent narration. Sweller (2008) notes that the modality effect takes place under similar settings as the split-attention effect in that both effects happen under situations with several sources of information.

As mentioned in Chapter 3, human working memory is limited. The dual modality approach is an instructional technique designed for increasing the effective capacity of our limited working memory. Working memory contains two partially separate sub-systems, one for processing visual information and one for dealing with audio information (Baddeley, 1992). However, the dual mode instruction is unlikely to be effective if one source of information is intelligible in isolation thus making the other source redundant. If information is self-explanatory via one source of information, it is better to present one source of information to accommodate the limitations of working

memory capacity (Diao, Chandler, & Sweller, 2007; Kalyuga, Chandler & Sweller, 1999).

A meta-analysis of the modality effect has shown the robustness of this effect (Ginns, 2005). Forty-three independent effects comprising 39 between subjects designs and four within subjects designs informed the meta-analysis and the findings agreed that, across the learning domains, the modality effect is robust. The outcome of the meta-analysis provided support for the fact that replacing a written explanatory text and another source of visual information with a spoken explanatory text and a visual source of information is more effective (Harskamp, Mayer, & Suhre, 2007; Tindall-Ford et al., 1997).

4.3.4 The Redundancy Effect

The redundancy effect (Sweller & Chandler, 1994) occurs when two sources of information, which are intelligible in isolation, are presented in slightly different forms. In situations where multiple sources of textual, or graphical, instruction can be understood independently, therefore only a single source of learning instruction should be used. Either the graphical source or the textual source should be used. The additional load on working memory presented by multiple sources makes the additional information redundant and can have an adverse effect on learning.

Unnecessarily increasing the number of elements of information increases element interactivity because novice learners are likely to be unaware of which elements are essential and which are redundant (Blayney et al., 2015). In such settings, they must use working memory resources to determine the necessity of all elements. The resultant increase in working memory load is likely to impose an extraneous cognitive load that interferes with learning (Chandler & Sweller, 1991, 1996; Leslie et al., 2012; Mayer et al., 2001; Morrison et al., 2014).

Redundancy of information also depends on the level of expertise of the learner. Attending to textual and graphical sources of instruction may be deemed redundant for the more experienced learner whilst novice learners may require more information. Kalyuga et al. (1999) demonstrated the relationship between redundancy and split-attention with electrical trainees. They concluded that novice trainees learned better from the textual explanation embedded in the wiring diagrams. However, when the trainees became more experienced with the process, the effectiveness of the integrated diagram and text decreased whilst the effectiveness of the diagram alone increased. The integrated diagrams were thus essential for the novice but redundant for expert learners Kalyuga et al. (1999).

4.3.5 Split-attention Effect

The split-attention effect occurs when learners are required to process and integrate multiple and separated sources of information (Carlson et al., 2003; Liu et al., 2012); for example, learning instructional material that is presented separately. The typical example is having a separate text and graph. Cognitive load theory suggests that such text should be integrated into the graphic components in such a way that the components are well understood. Much instructional material make use of both a diagrammatic component and a textual component of information which, as we have discussed, imposes a high demand on working memory because of the way the diagram and text are separated (Agostinho et al., 2013). Often a diagram is presented with the associated text above or below it. This manner of presentation introduces a split-attention effect in which the learner must attend to both the diagram and text because each element on its own provides insufficient information for solving the problem.

Florax and Ploetzner (2010) investigated learning from spatially organised text and picture and text. Groups were formed using text segmentation and picture labelling. The results showed that participants who learnt spatially integrated text and picture performed significantly better than participants who received continuous text (not in

bullets or numbered text format) and unlabelled picture. The results also showed that the students who learnt using the segmented text and the labelled picture were more successful than those who received continuous text and unlabelled picture group. Yeung, Jin, and Sweller (1998) presented an example of split attention, indicating that when a reader encounters an unfamiliar word when reading a passage, given a separate glossary, the reader leaves the text and turns to the vocabulary list. The learner temporarily stores its meaning and then returns to the text and tries to incorporate the meaning of the word into the passage. The split attention effect occurs when students are required to integrate and split their attention between multiple sources of information mentally. According to researchers, this has been shown to be a primary problem with some instructional designs (Florax & Ploetzner, 2010; Ward & Sweller, 1990).

Learning instructions containing text and diagrams that need to be mentally integrated to be understood should be restructured into physically integrated formats (examples of key studies include Austin, 2009; Ayres & Sweller, 2005; Chandler & Sweller, 1991, 1992, 1996; Cierniak et al., 2009; Florax & Ploetzner, 2010; Kalyuga et al., 1999; Kester, Kirschner, & Van Merriënboer, 2005; Liu et al., 2012; Pociask & Morrison, 2008; Tarmizi & Sweller, 1988). Currently, the most efficient known method for dealing with split-attention is thought to be through integrated instructions. This technique, which requires instructor-manipulated interventions, represents a form of instructor-managed influence over cognitive load (Paas et al., 2010).

A meta-analysis of the split-attention effect has revealed its robustness across many experimental settings (Ginns, 2006). Meta-analytic techniques were applied to 50 independent studies and revealed that, across a variety of learning domains and instructional formats, the split-attention effect is robust. The split-attention effect (e.g., Chandler & Sweller, 1991; Chandler & Sweller, 1996; Florax & Ploetzner, 2010; Rose & Wolfe, 2000) can arise because information is spatially separated (spatial contiguity

effect) (e.g., Clark & Mayer, 2008; Mayer, 2005) or temporally separated (temporal contiguity effect) (Ginns, 2006). Studies have shown that students often learn more when complex educational content is designed to reduce the space (spatial contiguity effect) or time (temporal contiguity effect) between disparate but related elements of learning content.

4.4 Cognitive Issues in Undergraduate Accounting Education

A few studies have investigated cognitive related issues in accounting. However, the call for change by employers of graduating accounting students focused the attention of many academics on the issue of understanding how students approach and solve accounting problems. Barbera (1996) proposed that management accountants should use intuition and be creative as well as be able to analyse using their cognitive skills when solving problems. The Dearing Report (1997) in the United Kingdom specified skills students should have, and these include cognitive skills, such as the ability in critical analysis or an understanding of methodologies. However, Coombs et al. (2000) cautions educators that curriculum emphasis should not be technical but that students must be taught in ways that emphasize a conceptual understanding.

Further studies on cognition invoked the concept of cognitive complexity. Cognitive complexity is a term used by Harvey et al. (1961); it holds that “all people may be ordered along a continuum from concrete to abstract, depending on their ability to differentiate and integrate information” (Goldstein & Blackman, 1978:136). Studies have also found that students studying accounting with different levels of cognitive complexity performed equally well on highly structured accounting questions. The students with high levels of cognitive complexity performed significantly better on unstructured examination questions (Amernic & Beechy, 1984). The studies reported in this thesis show enhanced learning when students self-manage split-attention.

4.5 Criticisms of CLT and How They Are Addressed in This Thesis

Caution must be taken when using the CLT strategies since every theory has its weaknesses and strengths. CLT, despite its usefulness, is no exception. Criticisms have been raised regarding how cognitive load is measured. During the early stages of CLT research, several indirect measures were used to measure it. These included computational models, error rates, assessing working memory load through a dual-task methodology and time on task (Sweller, 1988; Sweller et al., 2011). The gradual replacement of these methods in favour of a self-rating instrument developed by Paas (1992) occurred over the years. This instrument is a Likert-scale measure where participants are requested to rate their perceived amount of mental effort invested during the learning and testing phase. This rating scale has been used in many studies, though it has been criticised. The Likert-scale measure has been used inappropriately to measure different types of cognitive load in some studies (Kirschner, Ayres, & Chandler, 2011). In addition, there have been too many variations in the way the original validated instrument has been administered (Van Gog & Paas, 2008).

To meet this challenge, in addition to using the original Paas (1992) self-rating instrument, this thesis followed the recommendations of Van Gog, Kirschner, Kester, and Paas (2012) when using Likert-scale measurement. Van Gog et al. (2012) examined how timing and frequency affected cognitive load measures, as well as the interactions with problem complexity. They assessed mental effort ratings collected repetitively after each problem-solving task in a series with mental effort measured once at the end of the series. Van Gog et al. (2012) found that the timing and frequency of ratings influences their value, and repeated measures provided the most accurate data. These findings have significant implications for the measurement of cognitive load. This study implemented the recommendation of Van Gog et al. (2012).

The external validity of CLT studies has also been questioned (de Jong, 2010). This refers to the relevance and applicability of CLT research to realistic learning

environments. However, a number of studies have been conducted in educational environments and workplace settings (for example, Chandler & Sweller, 1991; Kalyuga et al., 2001; Clark et al., 2006; Florax & Ploetzner, 2010; Tindall-Ford, Chandler, & Sweller, 1997), and results indicate that multiple methods, that is both lab-based and realistic learning environments, yield the most effective experimental educational research. This study used a realistic educational learning environment (Mayer, 2010). Some studies have revealed a number of factors that mediate the instructional effects of the design guidelines (Wouters et al., 2008). The effectiveness of these guidelines depends on several mediating factors, such as spatial ability, prior knowledge, motivation, and age of the student.

4.6 Chapter Summary

The purpose of this chapter was to discuss CLT and its major implications for learning. To achieve this objective, the chapter proceeded through a description of human cognitive architecture as conceived by cognitive load theorists presented in Chapter 3. The chapter outlined the factors most salient to cognitive load theory. Paas' (1992) cognitive load measurement scale was then discussed as well as Paas and Van Merriënboer's (1994) model on relative condition efficiency which helps researchers measure perceived mental effort, an index of cognitive load. It was noted that relative condition efficiency provides a relatively simple means of comparing instructional conditions by combining mental effort ratings with performance scores.

Following this cognitive measurement discussion, the chapter examined those cognitive load theory effects that are relevant to this study. This section contained a summary of the expertise reversal effect, the split-attention effect, the worked example effect, the redundancy effect and the modality effect. This thesis sought to test CLT design principles for their relevance to introductory accounting to establish whether statistically significant improvements in overall student performance and cognitive load are

observed. The next chapter reviews studies on the self-management of cognitive load, another theoretical effect examined in the current study.

Chapter 5: Self-management of Cognitive Load: Background and Research Hypotheses

5.1 Introduction

This chapter examines studies on self-management of cognitive load. Only a handful of studies have explored self-management in the context of split-attention. The chapter discusses recent findings which show that instructional formats requiring students to self-manage split-attention may decrease the load on working memory. It will discuss the self-management methods used in various studies to physically move text to associated parts of a diagram on a digital platform or paper-based instructional formats and the effects of such movements on learning. Based on the self-management effect studies this chapter will conclude by hypothesising that superior learning outcomes result from carefully constructed self-managed instructional formats rather than conventional split-attention instructional formats.

5.2 Self-management Principles

The self-management effect was developed within a cognitive load framework about five years ago. The researchers involved noticed the high variability of instructional formats used on the worldwide web and elsewhere. This became kind of a fork in the road for cognitive load research. Largely two options were available to cognitive load theorists. The first was to keep on reconstructing deficient instructional formats (e.g., split attention formats) into more effective formats (e.g., integrated formats). However, given the sheer amount of information that now exists electronically, most of it generated without cognitive considerations, this does not seem plausible. Thus, the field started to examine self-managed learning. Learners can be given very specific coaching in identifying inefficient instructional formats and then be given examples of how to self-manage such load. The results of a number of studies have indicated that not only does this self-management work, it may also be more effective than any other cognitive

load formats for assisting transfer. This chapter will now proceed to explain the strategies of self-management and discuss related research.

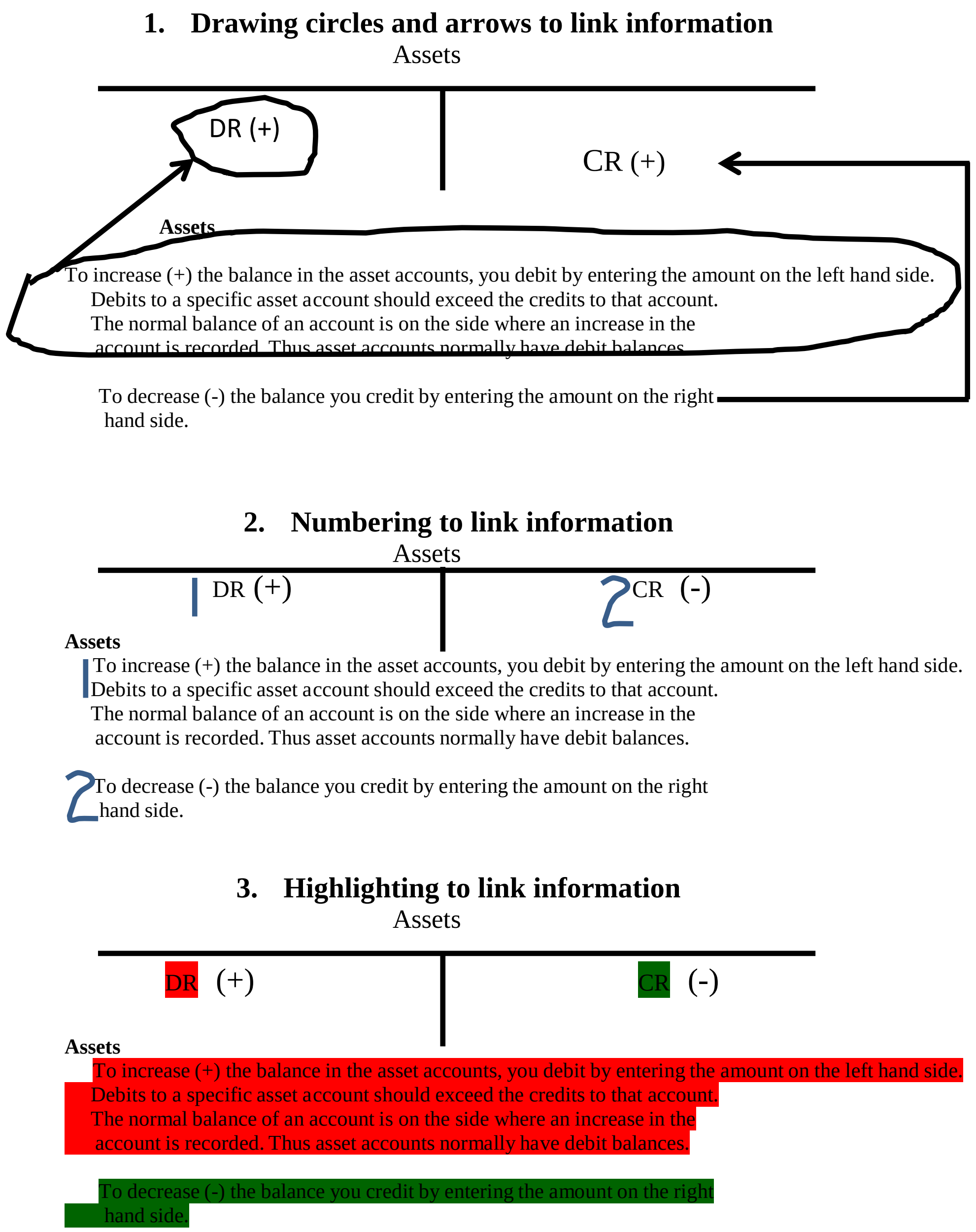


Figure 5.1: Example of self-management tasks

The self-management principle assumes that in the design of instructional material, the learner rather than the instructor may be in the best position to reorganise materials

effectively (Agostinho, Tindall-Ford, & Bokosmaty, 2014; Agostinho et al., 2013; Roodenrys et al., 2012; Tindall-Ford et al., 2015). The rationale seems to be that teaching learners to reorganize instructional material by integrating related text within a diagram online or on paper-based materials reduces the need to search and match and thus increases their understanding of concepts. This decreases the load on working memory and enhances learning (Tindall-Ford et al., 2015).

Self-management techniques were first researched by Roodenrys et al. (2012) who developed instructional materials to assist participants to integrate text with diagrams. The tasks the learners completed before learning the material were: drawing a circle around the information and then drawing an arrow to link its corresponding place on the diagram, numbering in sequence on the diagram and on the text; and, when reading material, highlighting with a highlighter, underlining, and marking circles on key words with a pencil or pen. Figure 5.1 above illustrates three ways of self-managing information in an area of introductory accounting context.

5.3 Pen and Paper-based Self-management Studies

Using educational psychology subjects, results of two experiments showed that it is feasible to instruct students on how to self-manage information (Roodenrys et al, 2012). Roodenrys et al. (2012) investigated the effectiveness of teaching tertiary students when they take control of their own learning and manage their own cognition in educational psychology. The experiments with educational psychology students showed the enhanced learning that follows from instructing students to self-manage split-attention.

An interesting result was that teaching the technique of self-management was transferable with the self-management group significantly outperforming both integrated and split-attention groups on transfer test items in a different learning domain. The transfer questions test the ability to transfer acquired knowledge when the demands of the question are higher than recall questions. Transfer is defined as applying what has

been learned during instruction to a novel situation (Mayer & Wittrock, 1996). In a technical domain such as accounting, learning automated rules through studying of conventionally designed instructional material is a time-consuming and effort-intensive process, which seems to inhibit the processing of aspects of the problem structure required for schema acquisition. The students' abilities to apply what they learned to situations different from those practised is what is referred to as *transfer* of learning in CLT (Paas, 1992; Paas & Van Merriënboer, 1994). Paas (1992) states that problems that are more similar to those encountered during instruction are near transfer whilst those less similar to those encountered during instruction are far transfer.

In Roodenrys et al. (2012), the self-management group reported a slightly higher mean performance than the split-attention group. For near transfer items, Roodenrys et al.'s (2012) study reported that the self-management group slightly outperformed the integrated group. The self-management group performed significantly better than the split attention group on near transfer items. Roodenrys et al. (2012) also concluded that self-management instructions need to be carefully constructed so that they would not result in an unnecessary cognitive load due to either split-attention or redundancy. Their studies also showed that the positive effects of self-managed instructions may be demonstrated more on transfer tasks.

5.4 Online Based Self-management Studies

Agostinho et al. (2013) examined whether students who received guidance to self-manage instructional material by relocating text objects to as close as possible to a diagram in an online environment would be able to decrease split-attention and consequently perform better than students who were studying under split-attention condition. Fifty-two university learners took part in two experiments, and results revealed that the self-managed group outperformed the split attention group. The conclusions derived from verbal protocols noted that in order for students to effectively self-manage, guidance and training needs to be explicit and more extensive.

Additionally, Tindall-Ford et al. (2015) examined secondary school students' self-managing of split-attention when learning about the properties of angles in mathematics. The learning task required students to integrate information spatially bringing together text with diagrammatic information. The students used tools to physically move text to associated parts of a diagram on a digital platform thus self-managing and reducing their split-attention. They found that the students who received instructor guidance to integrate text with a diagram outperformed students who received no such guidance on a later test. Thus the self-management group and integrated groups outperformed the split-attention group in the total test scores. Tindall-Ford et al. (2015) emphasised the need to continue investigating techniques that enable students to learn better even when working with poorly constructed learning materials to support their learning by self-managing their cognitive load. The research into the self-management effect has not consistently shown superior performance on recall and transfer items over both the integrated and split-attention format. This issue will be examined in the current thesis.

Both online and paper-based results suggest a possible self-management effect in educational psychology (Roodenrys et al., 2012), mathematics (Tindall-Ford et al., 2015) and digital platform (Agostinho et al., 2013). To this point only a handful of studies have explored self-management of split-attention (e.g., Roodenrys et al., 2012; Tindall-Ford et al., 2015). In an environment where students can gain access to a range of online diagrammatic information, it is imperative that learners are equipped with strategies on how to physically manipulate diagrams in ways that optimise their learning (Agostinho, Tindall-Ford, & Bokosmaty, 2014).

The relevance of these studies to this study is twofold, with respect to recall and transfer. First, on transfer, the studies have consistently reported superiority of self-management learning outcomes over split-attention on transfer performance items (Roodenrys et al., 2012). Second, on recall, some studies have reported the self-

managed condition performing as well as the split-attention condition (Agostinho et al., 2013). Empirical evidence based on transfer is promising with respect to whether self-management is an effective approach. As the authors (Agostinho et al., 2013; Roodenrys et al., 2012) point out, what needs to be emphasised is making the self-management instructions much more explicit. The results reported in this thesis will provide a further demonstration that may help make solid conclusions about the self-management effect.

5.5 Current Study: Research Problem and Hypotheses

Based on the above discussion, this study will examine the hypothesized superior learning outcomes of self-management instructions and integrated instructions over conventional split-attention instructions. Specifically predictions are expressed in terms of student performance as conditioned by the effects described below.

5.5.1 Performance by Design Group

(1) Performance by self-managed (group 3) and split-attention formats (group 1):

H1a: Students in the self-managed format will outperform students in the split-attention format in recall tests.

H1b: Students in the self-managed format will outperform students in the split-attention format in transfer tests.

Within cognitive load research (Sweller, 1988), experimental evidence has shown that split-attention material for novices left little processing capacity for schema acquisition, the capability to recall and the transfer of knowledge (e.g., Ayres & Sweller, 2005; Chandler & Sweller, 1991; Clark et al., 2006; Florax & Ploetzner, 2010). Most recent research (Roodenrys et al., 2012; Tindall-Ford et al., 2015) has revealed that self-managing the split-attention problem (such as in group 3) results in superior performance as compared to learners who have not been provided with any guidance. A few studies have demonstrated the potential of self-management as an effective strategy

for learning new information (Agostinho et al., 2014; Roodenrys et al., 2012; Tindall-Ford et al., 2015).

(2) Performance by the self-managed format group (group 3) and the integrated format group (group 2):

H2a: Students in the self-managed format group will outperform students in the integrated format group in recall tests.

H2b: Students in the self-managed format group will outperform students in the integrated format group in transfer tests.

Instructor-manipulated load has traditionally provided the necessary edits to ensure an integrated format (e.g., group 2) to manage cognitive load. For example, to enhance learning, researchers have successfully demonstrated integrating different information sources (Chandler & Sweller, 1991; Chandler & Sweller, 1996; Clark et. al., 2006; Florax & Ploetzner, 2010; Ginns, 2006; Mayer, 2002). While the instructor-manipulated load provides the learners with the best chance of facilitating learning, they rely on the instructor to perform the task of minimising the unnecessary cognitive load. Coincidentally, research encouraging students to manage their own cognitive load (e.g., group 3) has resulted in superior performance when compared with instructor-manipulated load (Roodenrys et al., 2012).

(3) Performance by integrated (group 2) and split-attention formats (group 1):

H3a: Students in the integrated format group will outperform students in the split-attention format group in recall tests.

H3b: Students in the integrated format group will outperform students in the split-attention format group in transfer tests.

5.5.2 Mental Effort

Subjective mental effort scores were also collected (see Paas, 1992; Paas et al., 2003), and they form the basis for the following predictions:

(4) Students in the split-attention format (group 1) will report higher effort (cognitive load) than students in the self-managed format (group 3);
(5) Students in the self-managed format group (group 3) will report lower cognitive load than students in the integrated format group (group 2); and,
(6) Students in the integrated format group (group 2) will report higher cognitive load than students in the self-managed split-attention format group (group 3).

Intuitions which drive these hypotheses can be explained in the following way. Cognitive load is increased by the need to mentally integrate various sources of information (Ayres & Sweller, 2005). Hence the split-attention format group should report higher cognitive load than any other group followed by the integrated format group and the self-management group. The integrated format refers to an instructor reorganising instructional material by physically integrating disparate sources of information to eliminate the need for mental integration. While research has shown that integration enhances learning, subsequent research has demonstrated self-management as an even more effective strategy for learning new information (Agostinho et al., 2014; Roodenrys et al., 2012; Tindall-Ford et al., 2015).

Early research on mental effort in cognitive load theory (CLT) has established that using well-developed instructional material which takes into account CLT principles would improve test performance scores in recall and transfer items with a lower investment in mental effort (Paas, 1992; Paas & Van Merriënboer, 1993; Paas et al, 2003). This has been achieved by a lower extraneous cognitive load on the learners due to the design of the instructional material. Therefore the mental effort hypothesis posits that the self-management format will result in the lowest mental load followed by the integrated format and split-attention format.

(7) Students in the self-managed format (group 3) would use guidance to self-manage and report lower cognitive load than students in the integrated format group (group 2) and split-attention group (group 1).

Results of research have shown that self-management groups perform better on transfer test items compared to split-attention groups (Agostinho et al., 2014; Roodenrys et al., 2012; Tindall-Ford et al., 2015). This result transpires despite the fact that the self-management group is required to carry out an additional task of moving text as close as possible to the diagram during the learning phase. In some studies (Roodenrys et al., 2012), qualitative results, which were attained through the use of verbal protocols, suggested that in order to enhance learning, explicit instructions and training are required for learners to successfully integrate text with diagrams. The research conducted to date shows that learners who are taught to self-manage instructional materials for themselves perform better than those in split-attention groups and record lower levels of cognitive load.

Self-management obliges learners to actively engage with the “to be learned content”, which may lead to enhanced processing and schema construction (Tindall-Ford et al., 2015). Research also indicates that when the information to be learned is high in complexity (high element interactivity) with a corresponding high working memory load, it is essential not to further burden novice learners’ working memories with additional activities or decision making that are not aligned with learning (e.g., Bokosmaty, Sweller & Kalyuga, 2014).

5.6 Chapter Summary

Chapter 5 presents research hypotheses motivated by previous research into self-management of the split-attention problem. The findings of these studies show that instructional formats requiring students to self-manage split-attention may decrease the load on working memory. The studies highlight the need to continue investigating

techniques that learners can use to overcome difficulties associated with poorly constructed learning materials. Integrated learning instructions prepared by an instructor have been shown to provide the most effective method for dealing with split-attention. It is gradually becoming distinct that learners require to take control of their own learning and experience independence. The physical movement of text to associated parts of a diagram on a digital platform or paper-based instructional formats is an example of a self-management technique. Based on the self-management effect reported in the discussed studies, this chapter concluded by hypothesising superior learning outcomes of carefully constructed self-management instructions over traditional split-attention instructions.

Chapter 6: Experimental Design and Task Description

In this chapter, l briefly present the context of the study and describe the procedural and experimental design used to test the hypotheses stated in Chapter 5.

6.1 Overview of the Context of the Study

This study was conducted at Great Zimbabwe University (GZU) located in central Zimbabwe (see Figure 6.1). All participants were undergraduate first-year students enrolled in a financial accounting subject offered by GZU in the Faculty of Commerce. Participants were enrolled in 13 majors including accounting (see Appendix A).

In 1980, Zimbabwe had one state university, University of Zimbabwe. Currently, there are 14 universities, 10 are state universities and 4 are church-run universities that are fully internationally accredited. All universities are registered with the Ministry of Higher Education before they operate. The minimum entry requirement for any university in Zimbabwe is five ordinary level subjects and at least two advanced level subject passes, including English. Admission into university is highly competitive, and the Zimbabwean government plays a major role in higher education by influencing policy, funding, establishing programs, and determining curricula across all universities. Great Zimbabwe University, like any other Zimbabwean university, runs programs that are the same as other universities, and the programme structure and content is generally similar. Hence Great Zimbabwe University can be presumed to be adequately representative of other Zimbabwean universities.

African contexts are rather rare in the education literature. This is important if issues of cognitive learning are to be comprehensively addressed worldwide. For example students in disadvantaged families (commonly found in developing world environments) often experience higher cognitive load than those in middle class families (Alibali & Siegler, 2004). Matters of cognition are contextual and vary from one culture

to another (Nisbett & Masuda, 2003). This suggests that underrepresentation of Africa may have resulted in less than comprehensive knowledge of cognition, learning and conceptual understanding (Gutchess, Schwartz, & Boduroğlu, 2011). Thus this study may be of particular relevance to CLT research.

Figure 6.1: Map showing the relative position of Great Zimbabwe University
Source: Adapted from classroom clipart (2009)

6.2 Overview of the Experiments and Treatment Levels (Independent Variables)

An experimental design is a plan for assigning experimental units to treatment levels and the statistical analysis associated with the plan (Kirk, 1995). In this study participants are assigned to three different instructional formats in order to examine the effect of these formats on learning outcomes within the context of cognitive load theory (CLT). The first instructional format is split-attention (Ayres & Sweller, 2005). The second is the integrated format which involves physically bringing together as close as possible text and associated diagrams. The third and final format is self-management. The study examined how learners can self-manage cognitive load when presented with instructional material. The redesigning of financial accounting instructional material to comply with the effects of split-attention in integrated and self-management contexts was created in order for comparisons to be made.

6.3 Rationale for Experimental Design

Quantitative methods were adopted in order to examine the techniques accounting students can use to manage their cognitive load when faced with split-attention learning material. Two experiments assessed student performance following instructional manipulations of one component of cognitive load, extraneous load. Experiment 1 evaluated the effect on learning by varying the instructional designs during one instruction session. Experiment 2 again evaluated the effect on learning by providing students with different instructional material from Experiment 1 with the aim of establishing whether self-management can be successfully transferred to a new learning domain.

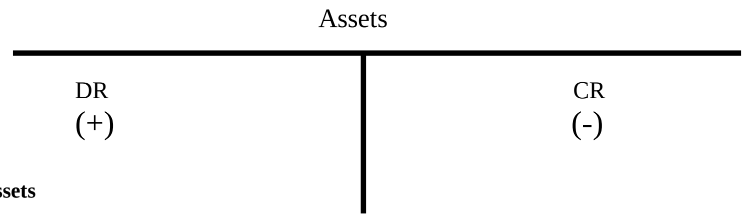
6.4 Two Experimental Studies

This study is comprised of two experiments. The first experiment sought to test the hypothesis that students in the self-managed format would perform better than students in the split-attention format. The second experiment sought to test the hypothesis that students in the self-managed format (group 3) would use guidance to self-manage and

report lower cognitive load than students in both the integrated format (group 2) and the split-attention format (group 1). Experiment 2 used different instructional materials compared to Experiment 1, and, in addition, it examined whether self-management participants (group 3) could use the knowledge of self-managing the split-attention effect they learned in Experiment 1 to a new learning domain. Participants were randomly assigned to one of three conditions. The experimental and task-specific differentiations across the three groups were as follows:

1. Conventional split-attention format instructional materials (group 1- split-attention).

   The instructional content for this group was formatted in the same way as in the textbook although it was presented on A3 sheets of paper so that students could see all the information from one sheet of paper. This is the presentation most common to accounting textbooks. An example is illustrated below (for comprehensive materials see Appendix G):



Assets
To increase (+) the balance in the asset accounts, you debit by entering the amount on the left hand side. To decrease (-) the balance you credit by entering the amount on the right hand side. Debits to a specific asset account should exceed the credits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus asset accounts normally have debit balances.

Figure 6.2: Example of conventional split-attention format found in textbooks

2. Integrated instructional format materials (Group 2 - instructor-managed cognitive load).

The instructional content was formatted in a different way to decrease split-attention by bringing the text as close as possible to the diagram (integrating). The integrated material was developed after reviewing the studies regarding split-attention (e.g., Agostinho et al., 2013; Ayres & Sweller, 2005; Chandler & Sweller, 1991; Florax & Ploetzner, 2010; Roodenrys et al., 2012; Tarmizi & Sweller, 1988; Tindall-Ford et al., 2015) and then reformatting the instructional material. An example is illustrated below (for comprehensive materials see Appendix J):

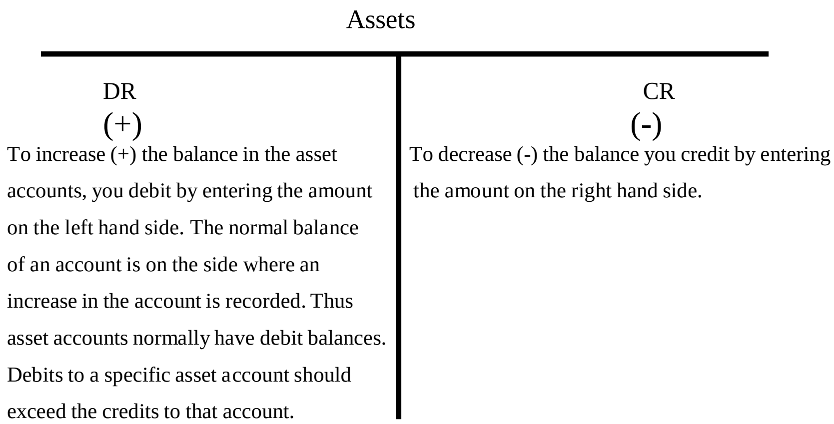


Figure 6.3: Example of integrated format

3. Self-managed instructional material and guidance on how to manage split-attention (Group 3 – self-managed cognitive load).

   The instructional content for Group 3 were designed in a way that assists learners to integrate the diagram with the text in a way related to the integrated instructional format materials. In addition to the review of the research concerning split-attention, a review of self-management literature was also done (Agostinho et al., 2013; Roodenrys et al., 2012; Tindall-Ford et al., 2015). In particular self-management techniques of highlighting, underlining, and linking text with diagrams using arrows as researched by Roodenrys et al. (2012), were deployed.

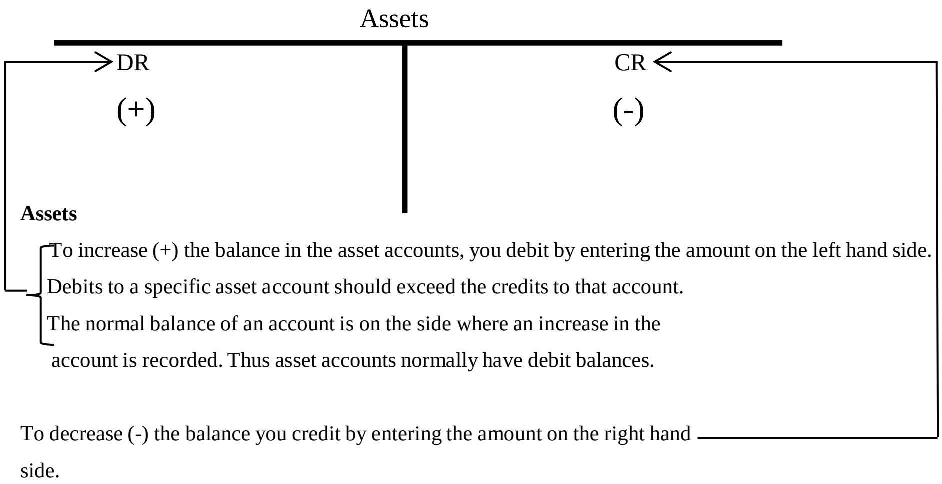


Figure 6.4: Example of self-management using arrows

6.4.1 Randomisation Process

Random assignment in this thesis helps to distribute the peculiar characteristics of participants over the treatment levels so that they are not likely to selectively bias the outcome of the experiments. Random selection ensured that each group in the population had an equal opportunity of being chosen to participate in the study (Gall et al., 1996). The random selection creates multiple study groups (in the experiments in this thesis - three) that include participants with similar characteristics so that the groups are equivalent at the beginning of the study. Random assignment generally "evens the playing field." This means that the three groups will presumably differ only in the treatment to which they are assigned. Therefore if the groups are equivalent except for the treatment that they receive, then any difference that is observed after comparing information collected about participants during the study can be attributed to the treatment or chance.

6.4.1.1 Random Number Generation and Assignment

Random allocation was achieved by computerised random creation of participant numbers and allocation to groups based on the numbers generated. To conduct random assignment to the self-managed, split-attention and integrated groups, an SPSS random numbers generator was employed to generate random numbers that were assigned to each of the 123 students. The data was then sorted in ascending order by the random number. The first 41 students were allocated to the split-attention group, the next 40 students were allocated to the integrated group, and the final 42 students were in the self-management group.

There is always a risk that random assignment of a small number of participants to control versus treatment groups may result in “imbalanced groups,” which would differ on important characteristics of performance and mental effort by pure chance. To avoid this risk, l used a large sample (123 students), and all students were assessed for their prior knowledge of accounting, in particular knowledge of the accounting equation and ratio analysis which were administered for Experiment 1 and Experiment 2.

6.4.2 Compliance Measures

Compliance was another measure included in the analysis for participants assigned to the self-management group (group 3). Compliance refers to the students’s use of the guidance accompanying the learning instructional materials. Indication of compliance involved inspecting the learning materials (A3 sheets of paper) to ascertain whether the students applied the guidance (to assist self-management). Participants were “compliant” if they used at least one of the three categories given in the guidance (see Appendix K) for Experiment 1. Some of the instructions required the participants to:

1. Draw a circle around the information.
2. Draw an arrow to link it to its corresponding place on the diagram.
3. Highlight, underline or number (e.g., each debit and credit in sequence on the diagram and on the text).

6.4.3 Mental Effort Ratings

The method used to assess cognitive load in this study, and which seems to be the preferred method in most recent research, is to use subjective rating scales. Two subjective rating scales have commonly been used. The first scale that has been used since the earliest research is mental effort rating scales (Paas, 1992; Paas et al., 2003; Van Gog & Paas, 2008). This scale results from asking learners to rate the amount of mental effort they have invested in completing a task on a 9-point Likert scale, ranging from “very, very low mental effort” to “very, very high mental effort.” The second widely used subjective measure of cognitive load is the rating of perceived task difficulty (Kalyuga et al., 1999; Marcus et al., 1996; Paas et al., 2003) which asks learners to rate the perceived difficulty of a task on a 9-point Likert scale, ranging from “very, very easy” to “very, very difficult.” As Schmeck, Opfermann, Van Gog, Paas and Leutner (2015) state, while perceived task difficulty and perceived mental effort may correlate, they are different constructs (also see Van Gog & Paas, 2008).

With this in mind, perceived mental effort rating was chosen as it is one of the measures that has widely been used in various cognitive load research studies since the early development of CLT (Paas, 1992; Paas et al., 2003; Van Gog & Paas, 2008). The scale’s (Paas, 1992) reliability (alpha > .8) and convergent, construct, and discriminate validity have been demonstrated (Gimino, 2000; Paas et al., 1994).

Mental effort ratings were solicited from participants at the end of the learning phase and after each question in the post test. For example, “How much mental effort did you invest for you to learn the material?” at the completion of the learning phase and “How much mental effort did you invest to answer this question?” at the end of each test question. The rating scale consists of a line marked with nine anchor points, each accompanied by a descriptive label indicating a degree of effort. For the learning phase, the question and rating scale was:

How much mental effort did you invest for you to learn the material? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

For the test phase, repeatedly after every task in the test phase, students had to rate how much mental effort they invested:

How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

6.4.4 Relative Effectiveness of the Instructional Conditions

The amount of mental effort a learner perceives as needed was used to calculate the instructional effectiveness of each treatment. Measures of cognitive load were combined with measures of performance to derive information on the relative effectiveness of the instructional conditions that were used in the study (self-management; split-attention; integrated). Therefore, the participants' mean ratings of mental effort in combination with the mean recall and transfer test results for each treatment were used to calculate their respective effectiveness. Each of the student scores for effort and performance were standardized. First, the total mean score was subtracted from each performance score, and the result was divided by the standard deviation giving a z-score for performance, P. A similar calculation for effort was done taking the total mean score for mental effort and subtracting it from each mental effort rating score and then dividing the result by the standard deviation giving a z-score for effort, R. Then an instructional condition efficiency score, E, was computed for each student using the formula:

$$E = \frac{(P - R)}{\sqrt{2}}$$

Where: E = instructional condition efficiency; P = performance z – score; and R = effort rating scale z score. For example assume that two groups (A & B) have the following mean levels of rating.

Instructional format	*Performance*	*Effort*
A (n=20)	-0.73	1.11
B (n=20)	0.91	-0.92

To arrive at the mean rating of A = -0.73, the mean performance of the 20 participants is found and then subtracted from each of the 20 performance scores. The result is then divided by the standard deviation of the performance scores to give a z-score for performance. A similar calculation for effort is done by taking the total mean score for effort of the 20 participants and subtracting from each individual difficulty rating score and then dividing the result by the standard deviation giving a z-score for effort, R. The instructional condition efficiency would therefore be:

$$\text{A:} \quad E = \frac{(P - R)}{\sqrt{2}} = \frac{(-0.72 - 1.11)}{\sqrt{2}} = -1.30$$

$$\text{B:} \quad E = \frac{(P - R)}{\sqrt{2}} = \frac{(0.91 - -0.92)}{\sqrt{2}} = 1.29$$

This can then be plotted on a graph to clearly visualise the high or low efficiency groups as shown in Figure 6. It can be concluded that B has high instructional efficiency whilst A has low instructional efficiency. In using this formula, a combination of low mental effort and high performance is a sign of high instructional efficiency. A high mental effort associated with low performance is a reflection of low instructional efficiency. Hence a combination mental effort and performance would indicate the level of student expertise. Students with higher expertise are able to achieve higher performance levels with less mental effort invested (Kalyuga, 2007). Thus, the levels of learner expertise

may be determined by this efficiency measure (Van Gog & Paas, 2008). The students were assessed to determine which group learned with high-instructional efficiency in all the learning measures (E) for recall and transfer. Graphical methods, helping to visualize the combined effects of the two measures were used to display the information.

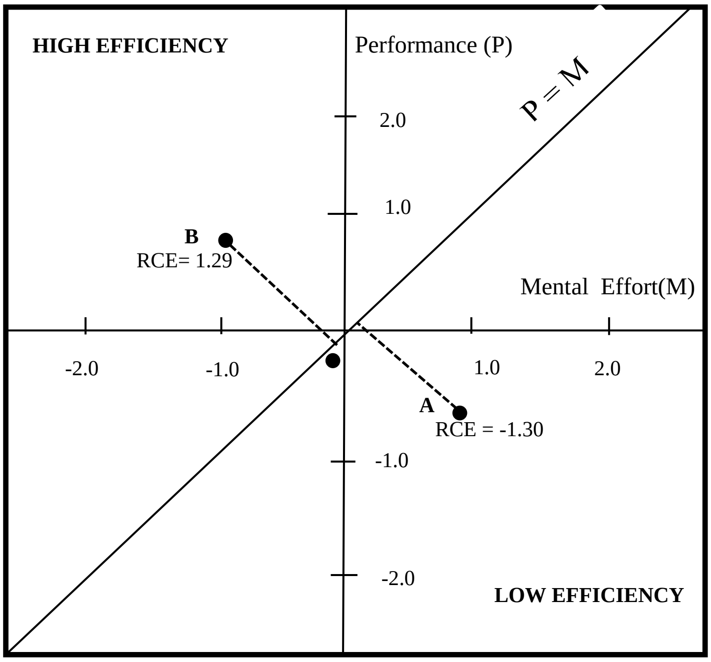


Figure 6.5: Example illustrating the instructional condition efficiency

In this formula, if the effort rating and performance z- scores are equal (P=R), then the efficiency is 0 (E=0); if the performance z score is higher than the effort rating z score (P>R), then instructional efficiency is positive (E> 0); and finally, if the performance z score is lower than the effort rating z-score (P<R), then instructional efficiency is negative (E< 0). In this thesis retention refers to the capability to recall instructional material at a future time in almost a similar way it was provided during the learning period (Mayer, 2002). Transfer is the capability of solving new problems, answering new questions or facilitating the learning of new material using what was learned (Mayer, 2002; Mayer & Wittrock, 1996).

6.4.5 Determination of the Statistical Analysis that will be Performed

6.4.5.1 Nature of Tasks

For this study, the tasks selected are learning about the accounting equation and ratio analysis. These two tasks were selected above other skill acquisition tasks since they almost always have separate text and diagrams and were likely to exhibit clear associations with measures of cognitive load. It was therefore a suitable medium for testing the research hypotheses, both because of the ubiquity of these areas across global accounting subjects and because of the fact that designs which yield split attention are prevalent for these areas.

6.4.5.2 ANOVA and Post-hoc Tests

A one-way analysis of variance (ANOVA) is used to establish whether there are any significant differences across the means of the three independent groups: split-attention, integrated, and self-managed groups. In this thesis, I form three groups (strata) based on the variable “instructional design.” The thesis will test whether the mean instructional design of strata (factors or independent variables) influences the mean performance scores (dependent variable). Since three types of instructional designs were compared, the factor “instructional design” has three levels. Since different participants were used across the levels, it is a between-subjects study.

There are a number of advantages of using ANOVA, such as greater statistical power due to more precise estimates, a simpler and more informative interpretation of the results, and much clearer explanation of the data with fewer parameters (Lazic, 2008). Other things being equal, a simpler explanation is preferable to a more complex one. Most importantly in this study, ANOVA is the most appropriate test as no source of variation other than the instructional design is anticipated. All other sources of variations known or suspected to influence the learning outcomes (dependent variable) are randomised over the treatments. However, since a one-way ANOVA cannot show

particular groups that were significantly different from each other, a post-hoc test using Tukey contrasts was used to determine which specific groups differed. These are multiple comparison analysis tests of pairwise differences each with their own particular strengths and limitations. The advantages of the Tukey method are that it tests all pairwise differences, it is simple to compute and it reduces the probability of making a Type I error. It is also robust with respect to unequal group sample sizes. One of its disadvantages is that it is not designed to test complex comparisons. However, the comparisons reported in this thesis are not complex.

6.5 Replication of Experiment 1

Fisher, as noted in the randomisation discussion, again popularised another principle of good experimentation: replication (Kirk, 1982). Replication is the observation of two or more experimental units under the same conditions. Replication was adopted in this thesis because it enables a researcher to obtain a more precise estimate of treatment effects.

6.6 Chapter Summary

Chapter 6 described the research procedures and design. First, an overview of the experiments was discussed, outlining the three instructional formats this study examines. These are: how students can self-manage cognitive load when they encounter instructional material with distinct split-attention, the conventional or traditional split-attention format normally found in textbooks, and the integrated format, which is often instructor manipulated. In addition, this chapter discussed rationales for the experimental design and a description of the two experimental studies, including specification of the randomisation procedure, compliance measures and the mental effort ratings. This chapter concluded with brief discussion of the statistical methods used to test the hypotheses.

Chapter 7: Experiments and Results

7.1 Experiment 1: Inquiry into the Split-attention Effect and Test of Whether Guidance to Assist Students to Self-manage Leads to Enhanced Learning Performance

7.1.1 Sample

The participants in Experiment 1 were 123 first-year undergraduate students from GZU. Participants were enrolled in 13 degree programs (see Appendix A), each taking an introduction to accounting subject. A power analysis using the Gpower computer program (Faul, Erdfelder, Lang, & Buchner, 2007) indicated that a total sample of 40 people would be needed to detect large effects (d=.8) with 97% power using a t test between means with alpha at .05. A pre-test questionnaire (see Appendix F) was used to collect information concerning each participant’s gender, age, language, and knowledge of accounting. In total, 51% male and 49% female students were randomly assigned to one of the three conditions. There were 41 students in the split-attention group (Group 1; 22 males and 19 females, M = 22 years old, SD = 2.22), 40 students in the integrated group (Group 2; 21 males and 19 females, M = 20 years old, SD = 1.48), and 42 students in the self-management group (Group 3; 20 males and 22 females, M = 21 years old, SD = 2.80) who participated in the study at Great Zimbabwe University. One student in Group 1 and 2 students in Group 2 did not complete both Experiment 1 and 2. Their responses to Experiment 1 were not included in the analysis. Students participated voluntarily in the study, and were not paid for participation. The distribution of participants within each instructional group by gender and first language is shown in Table 7.1.

Table 7.1: *Experiment 1 percentages for gender and first language as a function of instructional condition*

	Gender		First language	
Instructional format	Male	Female	Shona	Ndebele
Split-attention (n=41)	54%	46%	93%	7%
Integrated (n=40)	52%	48%	97%	3%
Self-managed (n= 42)	48%	52%	95%	5%

Note. Shona and Ndebele are the two major languages in Zimbabwe. The official language of instruction is English in all schools and universities.

The 123 participants in both the first and second experiment ranged in gender from 46% to 54% males in each instructional format group. The dominant language spoken by the participants is Shona with over 93% in each instructional format. Participants' gender and linguistic homogeneity was thus apparent across the groups. All students had passed a high school formal English language examination. The students' language proficiency was sufficiently high to respond to questions in English.

7.1.2 Test of the Split-attention Effect

According to our current understanding of cognitive load theory, the split-attention effect has a deleterious effect on learning in most cases. The split-attention effect has primarily been demonstrated using mathematics, science, and other disciplines. Since financial accounting is a technical subject, the experiment sought to test the split-attention effect in a discipline which somewhat resembles other technically quantitative disciplines in which the effect has been demonstrated. In reviewing material from the textbook Weygandt et al. (2010:53-54 & 783-785), it was observed that various sources of information were required by referring to diagrams and text below the diagrams. Students had to refer to the text and return to the diagrams and integrate the information. This is a very salient example of textual presentation that requires split-attention.

Cognitive load theory suggests that numerous sources of information perhaps must be substituted with an integrated, single source of information. This reduces extraneous cognitive load since learners would not need to mentally integrate the multiple information sources. In the integrated format, in this study, the learning material was integrated by bringing the material as close as possible to the relevant parts of a diagram. For the self-management format, students were given instructions on how to integrate multiple sources of information. In the split-attention group the material was not reorganised and resembled the learning material normally found in textbooks.

In Experiment 1, those students in both the integrated format group (Group 2) and the self-management group (Group 3) would be expected to outperform students in the split-attention format group (Group 1). This is due to the need to exert less mental effort than is required by those in the split-attention group. This expectation follows from the fact that split-attention requires that more working memory resources be utilised.

7.1.3 Materials

The paper-and-pen based materials covered the introductory accounting topics as well as a pre-test questionnaire and A3 pages of learning materials which included a mental effort rating question at the end of the learning phase and each test question. There were three pages of recall and transfer test questions to be answered used in the test phase, including a requirement to rate mental effort after answering every test question.

The learning materials were produced by the researcher (See Appendices G, H, and I). The materials were actual teaching materials used in a realistic teaching and learning environment. The instructional materials explained the basic accounting equation and the debit/credit rules and their effects on accounts presented in an accounting textbook (Weygandt et al., 2010:53-54 & 783-785).

7.1.3.1 Format of the Materials

The first set of instructional material was taken directly from the textbook without any changes. This constituted the material for Group 1, the split-attention format group (see Appendix G). The second set of material combined text and diagrams for Group 2 (the integrated format group) (see Appendix H). Group 3 materials included written guidance on how to integrate the diagrams and text in order to enhance learning. The guidance consisted of three tips that were included at the beginning of the instructional materials suggesting that they do the following:

- For Experiment 1, draw a circle around the information. This was around each debit and credit. For Experiment 2, this was around each ratio.
- Draw an arrow to link it to its corresponding place on the diagram for Experiment 1 on each debit and credit. For Experiment 2, draw the arrow on each ratio.
- Highlight with a highlighter, underline or number in sequence on the diagram and on the text with a pencil or pen. For Experiment 1 do so for each debit and credit. For Experiment 2, do so for each ratio (see Appendix K).

These are the same strategies extensively researched by Roodenrys et al. (2012) and represent the most accepted current method of employing self-management of cognitive load.

7.1.4 Pre-test of Age and Knowledge of Accounting

Students reported their understanding of the specific area of accounting on a 5-grade category. The numerical values and labels ranged from very poor to expert. The scale was provided and explained before the beginning of the experiment.

1----------------------2-------------------3----------------4--------------------5

Very poor	Poor	Fair	Good	Expert

The means and standard deviations of these responses are shown in Table 7.2. A follow up question asked whether they had ever encountered the accounting equation before;

and if so, to briefly explain what they knew about the accounting equation. The second part of the question required participants to describe their knowledge of ratios in accounting.

A one-way analysis of variance (ANOVA) was conducted on pre-test responses of age and basic knowledge of accounting to explore differences across the three groups involved in Experiment 1 and Experiment 2. Means and standard deviations are shown in Table 7.2.

Table 7.2: *Means and standard deviations for pre-test as a function of instructional condition*

	Age		Knowledge of Accounting	
Instructional format	Mean	Standard deviation	Mean (Maximum rank = 5)	Standard deviation
Split-attention (n=41)	21.04	1.95	2.10	0.37
Integrated(n=40)	20.35	1.47	1.98	0.42
Self-managed (n= 42)	21.19	2.79	2.02	0.27

Note. Actual responses were 1 to 5 for knowledge of accounting.

The one-way ANOVAs for pre-test questions demonstrate no significant main effect of group for age ($F(2,120) = 1.769$, $p = .175$) and knowledge of accounting ($F(2,120) = 1.191$, $p = .307$), thus enhancing the likelihood that any statistically significant differences detected later are more likely due to the different treatment conditions.

7.1.5 Procedure

7.1.5.1 General Procedure

Approval to conduct this study was received from the Human Research Ethics Committee at the University of Wollongong (see Appendix C). Following the guidelines provided by the University of Wollongong Human Research Ethics Committee, a

consent form (see Appendix D) was developed to provide every participant in the study with information concerning the confidentiality conditions of the study, purpose, description and procedures. The form also described the participant's rights as well as the risks associated with participation, estimated time needed to complete the task and contact information for any questions or concerns. Participation in the study was voluntary, and there was no credit for participation.

Demographic and other participant data were collected by using a pre-coded number on the learning materials and question papers of SP1 to SP 41 for the split-attention group, IN1 to IN40 for the integrated group, and SM1 to SM42 for the self-managed group in order to guarantee anonymous data acquisition. Participants were also told that their data would be treated as strictly confidential and that neither the researcher nor any other person could match answers provided to a specific participant. Participants were given participant information sheets and consent forms (Appendix D) and they indicated their agreement by signing the form. Completion of the consent form took on average 10 minutes.

7.1.5.2 Pilot Study

A pilot study was conducted before the first experiment. It aimed at refining instructional guidance, instructional content, and time that should be allowed for each phase of the studies. Five students from the same university took part. Those five students did not participate in the main experiment. Based on the pre-test, instructions for the self -management group which were initially written in paragraph format were changed to bullet point form. The time limit, for both the learning phase and test phase, was determined in the pilot study.

7.1.5.3 Study Phases

Experiment 1 included three phases conducted during the teaching of financial accounting to first-year university students in the first semester. In the first phase

participants provided information about their age, gender, language, and knowledge of accounting. This took ten minutes. In the learning phase, the participants were given 15 minutes to review the learning materials provided to them. In the third and final phase, the researcher administered the test that was formatted as a single-sided A4 booklet. The test consisted of recall and transfer items. The participants were given 45 minutes to complete the test.

The time given to complete the test was strictly controlled to avoid the possibility of a systematic difference in processing time across the split-attention, integrated and self-managed groups. Research has demonstrated that processing time is positively related to recall (Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Cooper & Pantle, 1967). The test was formatted as a single-sided A4 booklet. The test for Experiment 1 consisted of 28 recall and 11 transfer items. The participants were given 45 minutes to complete the test. An example of a recall question in the test phase required students to write the basic accounting equation. Recall questions required a student to retrieve information that has been learned (Carpenter, 2012). An example of a transfer question is: In May, Company X records the transaction by a debit to Accounts Receivable for $5,000 and a credit to Service Revenues for $5,000. What is the effect of this entry upon the accounting equation for Company X? Tick the appropriate box.

Assets:	Increase	Decrease	No effect
Liabilities:	Increase	Decrease	No effect
Owner’s (or Stockholders’) equity:	Increase	Decrease	No effect

The transfer questions tested the ability to transfer acquired knowledge, and the demands of the questions were higher than recall questions (see Appendix L & P). Transfer questions require a student to apply what has been learned during instruction to a novel situation (Mayer & Wittrock, 1996).

Participants provided mental effort ratings after the learning phase and after attempting every question as outlined by Paas (1992). Participants wrote answers and any comments they wished to provide on the blank spaces immediately below the questions. The researcher collected all the test booklets soon after the students completed the tasks.

7.1.5.4 Rating of Mental Effort

To measure perceived load, this study used Paas' (1992) and Paas et al.'s (2003) 9-point subjective cognitive load rating scale. This is an established scale to measure levels of cognitive load (Ayres & Paas, 2012) (see Appendix B). As previously stated, the scale's (Paas, 1992) reliability (alpha > .8) and convergent, construct, and discriminant validity have been demonstrated (Gimino, 2000; Paas et al., 1994). Paas gave permission for use of the scale in this research study. The participants had to translate the perceived amount of mental effort into a numerical value. Students were required to rate "How much mental effort did you invest for you to learn the material?" and "How much mental effort did you invest to answer this question?" by reporting their invested effort by circling a 9-grade category scale from *very, very low mental effort* (1) to *very, very high mental effort* (9). The rating scale was explained and illustrated to the participants before the beginning of the experiment.

7.1.6 Results and Discussion

In the sections that follow, results of one-way analyses of variance (ANOVAs) for Experiment 1 are presented as follows:

- reliability
- rating for mental effort invested in the learning phase
- recall test performance scores
- ratings of mental effort invested in the recall test phase
- transfer test performance scores
- ratings of mental effort invested in the transfer test phase
- relative efficiency of instructional conditions.

7.1.6.1 Reliability

The reliability of the scale was estimated with Cronbach's coefficient alpha in the present thesis. The data from the recall test scores and transfer test scores were entered and run in SPSS using the reliability analysis function. For the internal consistency check for the recall test scores and transfer test scores, all groups were first combined and then separated by treatment group to ensure that internal consistency for all groups was established.

Experiment 1 combined results displayed a high level of internal consistency as shown by both the recall and transfer test results. The results showed a recall Chronbach's α of .946 for Experiment 1 and .918 for Experiment 2. The transfer Chronbach's α for Experiment 1 was .892 and .882 for Experiment 2. Overall, Chronbach's α for the self-management of cognitive load experiment ranged between .806 and .885 among the three treatment groups. The recall results ranged between .882 and .946 and the transfer Chronbach's α ranged between .806 and .892. The internal consistency results for the recall test learning scores were similar to the results found with the transfer of learning results for both Experiment 1 and Experiment 2. Table 7.3 provides the results of this analysis.

Table 7.3: *Internal consistency results for self-management of cognitive load experiments*

	Combined		Group 1		Group 2		Group 3	
	Cases	α	Cases	α	Cases	α	Cases	α
Experiment 1								
Recall	123	0.946	41	0.872	40	0.880	42	0.810
Transfer	123	0.892	41	0.806	40	0.836	42	0.885
Experiment 2								
Recall	123	0.918	41	0.820	40	0.845	42	0.830
Transfer	123	0.882	41	0.846	40	0.870	42	0.804

As shown in Table 7.3, the internal consistency measures of the self-management of cognitive load experiment were also strong when reviewing all treatment groups combined or with each treatment group analysed separately. Gall et al. (2003) states that for research purposes, having a reliability of .80 or higher is considered sufficiently reliable.

7.1.6.2 Mental Effort Ratings

Results from the one-way ANOVA for mental effort invested in the learning phase are shown in Table 7.4. They indicate significant differences across the three formats, ($F(2, 120) = 75.77$, $p < 0.05$, effect size (partial $\eta^2 = 0.55$)). Consistent with predictions, there were large and significant between-group differences on mean mental effort rating on learning results. Mean learning phase ratings showed that the self-managed group reported lower levels of cognitive load than the integrated group, with the split-attention group reporting the highest level of cognitive load.

A Tukey post-hoc test for learning phase revealed that the mental effort factor was statistically significant with the self-managed group recording the lowest cognitive load (4.02 rating, $p < 0.05$) compared to the integrated format group (6.80 rating, $p < 0.05$), $d = 1.71$, and split-attention format group (7.90 rating, $p < 0.05$), d =2.94. Tukey post-hoc tests also revealed that the integrated format group reported a significantly lower level of perceived cognitive load compared to the split-attention format group, $d = 0.74$, indicating a large effect size (Cohen, 1988).

Table 7.4: *Experiment 1 means and standard deviations for learning phase mental effort ratings*

	Learning phase	
Instructional format	Mean rating	Standard deviation
Split-attention (n=41)	7.90	1.16
Integrated (n=40)	6.80	1.77
Self-managed (n= 42)	4.02	1.46

Note. Actual mental effort ratings were 0 to 9 for cognitive load.

7.1.6.3 Performance Measures

A one-way analysis of variance (ANOVA) was conducted on test performance scores to explore differences across the three groups involved in Experiment 1. Means and standard deviations are shown in Table 7.5.

A one-way ANOVA for recall scores showed a statistically significant main effect for the recall test items ($F(2, 120) = 54.834$, $p < 0.05$, effect size (partial $\eta^2 = 0.478$)). Mean recall and transfer scores showed that Group 3 (the self-managed format) had higher scores than Group 2 (the integrated format) which in turn had higher scores than Group 1 (the split-attention format). Consistent with predictions, post-hoc comparisons using Tukey contrasts showed that the self-managed format group performed significantly better than the split-attention group, $d = 2.17$, and the integrated group, $d = 1.45$, with the integrated format group performing better than the split-attention format group, $d = 0.73$, indicating a large effect size (Cohen, 1988).

Table 7.5: *Experiment 1 means and standard deviations for recall and transfer test scores*

	Recall		Transfer	
Instructional format	Mean	SD	Mean	SD
Split-attention (n=41)	13.98	3.71	4.41	1.96
Percentage correct	49.93		36.73	
Integrated (n=40)	16.58	3.46	6.40	2.16
Percentage correct	59.18		53.30	
Self-managed (n= 42)	22.38	4.04	8.02	2.01
Percentage correct	80.00		66.83	

Note. Actual raw score ranges were 0 to 28 for recall, 0 to 11 for transfer. SD = standard deviation

The one-way ANOVA for transfer questions also demonstrated a significant main effect of group ($F(2, 120) = 32.478$, $p < 0.05$, and effect size (partial $\eta^2 = 0.351$)). Post-hoc comparisons using Tukey contrasts showed that the self-managed format group performed significantly better than the split-attention group, $d = 1.82$, and the integrated format group, $d = 0.78$. Again the integrated format group performed better than the conventional split-attention format group, $d = 0.96$.

7.1.6.4 Mental Effort Rating on Instruction

After the learning phase and after each test question, students were asked to rank their mental effort. A one-way ANOVA was conducted on the instructional rating (of mental effort) that the participants provided. Table 7.6 shows the mean ratings and standard deviations for the ratings of the test phase. Consistent with predictions, there were large and significant between-group differences on mean recall results ($F(2, 120) = 144.973$, $p < 0.05$, effect size (partial $\eta^2 = 0.707$)).

Table 7.6: *Experiment 1 mental effort rating means and standard deviations for test phase based on one-way ANOVA under the three instructional conditions*

	Recall		Transfer	
Instructional format	Mean rating	SD	Mean rating	SD
Split-attention (n=41)	7.49	0.98	5.88	0.93
Integrated (n=40)	4.55	1.36	5.00	0.94
Self-managed (n= 42)	2.93	1.33	3.52	0.99

Note. Actual score ranges were 0 to 9 for cognitive load. SD = Standard deviation

Transfer items also revealed a significant effect between-groups ($F(2,120) = 64.834$, $p < 0.05$, effect size (partial $\eta^2 = 0.519$)). Mean recall and transfer ratings showed that the self-managed group reported lower levels of cognitive load than the integrated group. The perceived amount of mental effort invested with the split-attention format was higher than that invested with the integrated format. A follow up Tukey post-hoc test for recall revealed that the mental effort was statistically significant with the self-managed group recording the lowest cognitive load (2.93 rating, $p < 0.05$) compared to the integrated format group (4.55 rating, $p < 0.05$), $d = 1.21$ and split-attention format (7.49 rating, $p < 0.05$), $d = 3.90$. Tukey post-hoc tests also revealed that the integrated format group (4.55 rating, $p < 0.05$) reported a significantly lower level of perceived cognitive load compared to the split-attention format group (7.49 rating, $p < 0.05$), $d = 1.32$. Similarly a Tukey post-hoc test for transfer items revealed that the cognitive load was statistically significant with the self-managed format group recording the lowest cognitive load (3.52 rating, $p < 0.05$) compared to the integrated format group (5.00 rating, $p < 0.05$), $d = 1.53$, and the split-attention format group (5.88 rating, $p < 0.05$), $d = 2.45$. A Tukey post-hoc test also revealed that the integrated format group (5.00 rating, $p < 0.05$) reported a significantly lower level of cognitive load compared to the conventional split-attention group (5.88 rating, $p < 0.05$), $d = 0.93$.

7.1.6.5 Relative Efficiency of Instructional Conditions

Cognitive load theory offers principles that lead to enhanced learning efficiency (Clark et al., 2006). As mentioned in Chapter 4, researchers have developed ways to measure that efficiency. Performance efficiency can offer insight on the relative involvement of participants across different instructional conditions. Low mental effort together with a high performance score will yield a high instructional efficiency, while high mental effort together with a low performance score suggests low efficiency.

Performance was measured as the scores obtained in responding to the accounting questions, and the mental effort was measured as the degree of perceived mental effort of the task ranging from a value of 1 to 9. The performance scores and the mental effort rating by the participants were first standardised to permit comparisons. Therefore, as stated previously, the efficiency scores (Paas & Van Merriënboer, 1993; Kalyuga, 2009) were calculated by using the following formula:

$E = (P - R)/\sqrt{2}$

Where: E = instructional condition efficiency;

P = performance z – score; and

R = effort rating scale z – score.

The outcome of this formula results in a construct known as relative condition efficiency which measures perceived mental effort. It is an index of cognitive load. The group mean z-scores are compared through a one-way analysis of variance (ANOVA), tabulated and presented below. Table 7.7 shows the means and standard deviations of the instructional efficiency of recall and transfer tasks.

Table 7.7: *Experiment 1 means and standard deviations of instructional efficiency*

	Instructional efficiency			
	Recall		Transfer	
Instructional format	Mean	SD	Mean	SD
Split-attention (n=41)	-1.29	0.78	-1.09	0.95
Integrated (n=40)	-0.03	0.75	-0.09	1.03
Self-managed(n= 42)	1.29	0.94	1.15	1.04

Note. SD = Standard deviation

One-way ANOVA results showed a significant effect between-groups for recall items ($F(2, 120) = 100.695$, $p < 0.05$, effect size (partial $\eta^2 = 0.627$)). Mean recall instructional efficiency ratings showed that the self-managed group had higher instructional efficiency than the integrated group. The integrated group in turn had a higher instructional efficiency than the split-attention group. The findings further showed the self-managed group had a positive mean efficiency value, whereas the split-attention and integrated groups had negative efficiency values. In other words, the self-managed group had higher performance efficiency than the split-attention and integrated groups on the recall and transfer tasks.

A Tukey post-hoc test revealed a significant difference between the split-attention group and the integrated format group ($F(2, 120)$ $p < 0.05$). There was also a significant difference between the split-attention group and the self-managed group ($F(2, 120)$ $p < 0.05$). The self-managed group had a higher instructional efficiency than the split-attention group. In addition, the self-managed group had significantly higher instructional efficiency than the integrated group (F(2, 120) $p < 0.05$).

A one-way ANOVA for the transfer test items demonstrated a significant main effect of group ($F(2, 120) = 51.360$, $p < 0.05$, effect size (partial $\eta^2 = 0.461$)). Post-hoc comparisons using Tukey contrasts revealed that there were statistically significant

differences among all the groups. The integrated group revealed significantly higher instructional efficiency than the split-attention group (F(2, 120) $p < 0.05$). The self-managed group also revealed a higher instructional efficiency than the split-attention group (F(2, 120) $p < 0.05$). Finally, the self-managed group revealed a significantly higher instructional efficiency than the integrated group (F(2, 120) $p < 0.05$). An analysis for both recall means of instructional efficiency was conducted. The means of the standardized scores are tabulated in Table 7.8. The findings further reveal that the self-managed group had a positive mean relative condition efficiency value, whereas the split-attention and integrated groups had negative efficiency values. In other words, the self-managed group had higher performance efficiency than the split-attention and integrated groups on the recall and transfer tasks.

Table 7.8: *Experiment 1 performance, effort, and relative condition efficiency means for recall*

	Level of rating on recall		
Instructional format	Performance	Effort	Relative condition efficiency
Split-attention (n=41)	- 0.72	1.11	- 1.30
Integrated (n=40)	- 0.22	- 0.18	- 0.03
Self-managed (n= 42)	0.91	- 0.91	1.29

7.1.6.6 Graphical Illustration of the Relative Condition Efficiency for Recall

As can be seen in Table 7.8, the efficiencies of both split-attention format and the integrated format are negative suggesting a degree of inefficiency. To give a better visual illustration and interpretation of the differences across the instructional conditions, the recall means of the standardized scores in Table 7.8 were then plotted in a coordinate system as dots representing the instructional condition (see Figure 7.1).

Figure 7.1 presents a z-score for performance, P, and a z-score for effort, R, which are denoted on the Cartesian axes of effort (horizontal) and performance (vertical). Specific

points for mental effort z-scores and related performance z-scores of experimental conditions are shown in this coordinate system.

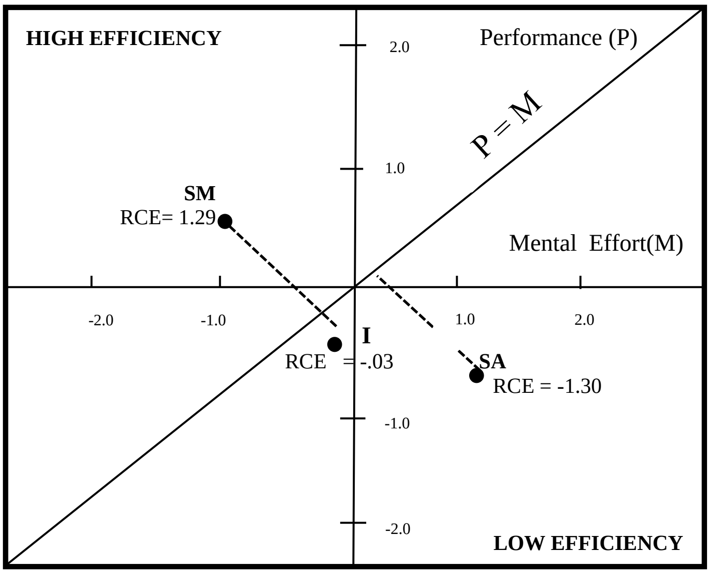


Figure 7.1: Experiment 1 relative condition efficiency representation for three training conditions
SA=split-attention-Group 1, I = integrated-Group 2, and SM=self-managed-Group 3
RCE=Relative Condition Efficiency

Instructional Efficiency (E) is now determined by the perpendicular distance from each of the dots to the diagonal Performance (P) – Mental effort line (M), (P–M line). As explained earlier, a low mental effort together with high performance score will yield a high instructional efficiency, while high mental effort together with a low performance score will result in a low efficiency score.

As can be seen in Figure 7.1, the efficiencies of both split-attention and integrated participants are below the Performance – Mental Effort line. The self-managed participants were above the Performance – Mental Effort line thus demonstrating a substantial efficiency in the transfer questions. However, when comparing the split-attention and integrated groups, the integrated group seems to be far more

instructionally efficient. Overall, the self-managed group demonstrated substantially higher efficiency in the recall questions than the other two groups.

The extent of the differences among the groups is illustrated by Figure 7.2. The integrated group was more efficient than the split-attention group. Figure 7.2 demonstrates the relationship between instructional formats and the respective relative condition efficiency.

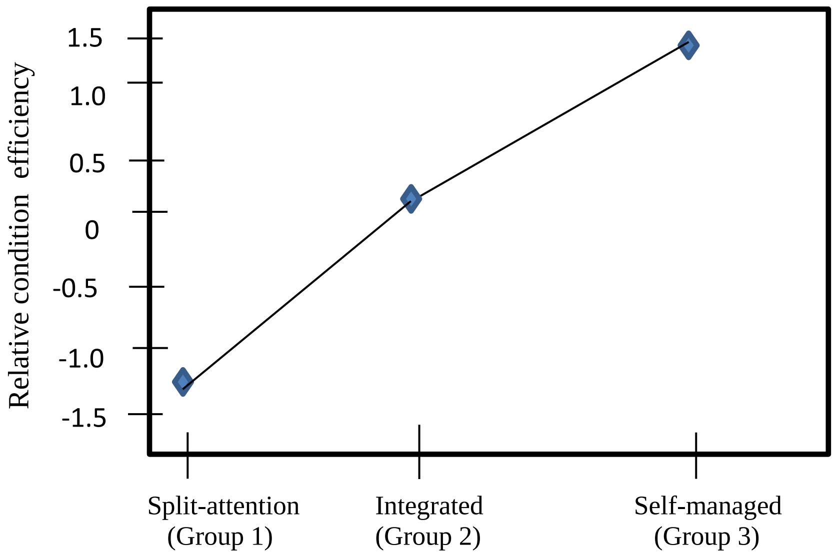


Figure 7.2: Experiment 1 instructional formats and relative condition efficiency

7.1.6.7 Graphical Illustration of the Relative Condition Efficiency for Transfer

Analysis of transfer means of instructional efficiency was conducted. The means of the standardized scores in Table 7.9 were plotted in Figure 7.4. Figure 7.4 gives a z-score for effort, R, and a z-score for performance, P.

Table 7.9: *Experiment 1 performance, effort, and relative condition efficiency means for transfer*

	Level of rating on transfer test		
Instructional condition	Performance	Effort	Relative condition efficiency
Split-attention (n=41)	-0.75	0.79	-1.09
Integrated (n=40)	0.04	0.17	-0.09
Self-managed (n= 42)	0.69	-0.93	1.15

Figure 7.3 below gives a graphic presentation of the relative condition efficiency of the transfer tasks for each instructional group. The relative condition efficiencies of both split-attention and integrated groups are again negative and below the Performance (P) - Mental effort (M) line. This suggests that only the self-managed group demonstrates substantial relative condition efficiency in the transfer questions since it is above the Performance (P) - Mental effort (M) line. The integrated format group was relatively more efficient than the split-attention format group.

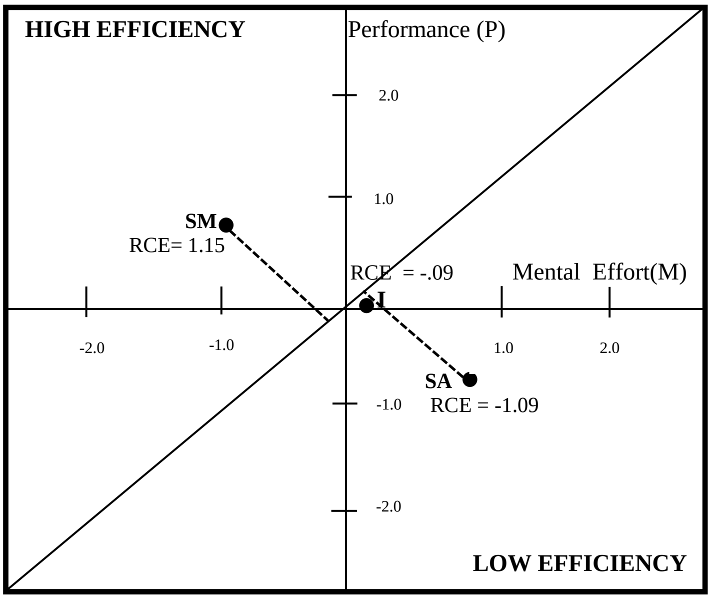


Figure 7.3: Experiment 1 relative condition efficiency representation as a function of three training conditions

SA=split-attention, I = integrated, and SM=self-managed, RCE=Relative Condition Efficiency

The extent of the differences among the groups is illustrated by Figure 7.4 below. The figure demonstrates the relationship between instructional formats and the respective efficiency. The relative instructional efficiency for the self-managed group was higher than it was for the split-attention and integrated groups.

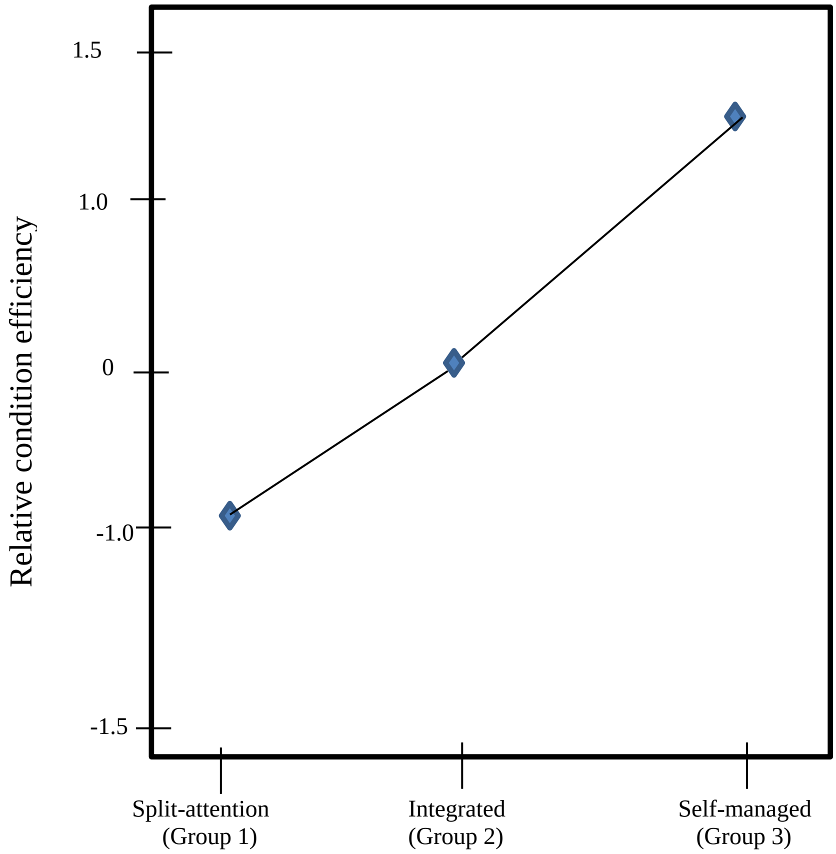


Figure 7.4: Experiment 1 relative condition efficiency as a function of instructional formats

7.1.6.8 Overall Comparison of Recall and Transfer Instructional Condition Efficiency for Experiment 1

The mean overall instructional efficiency for recall items and transfer items per experimental group is shown in Figure 7.5. The diagram demonstrates the similarities obtained on the instructional efficiency of both recall and transfer in Experiment 1.

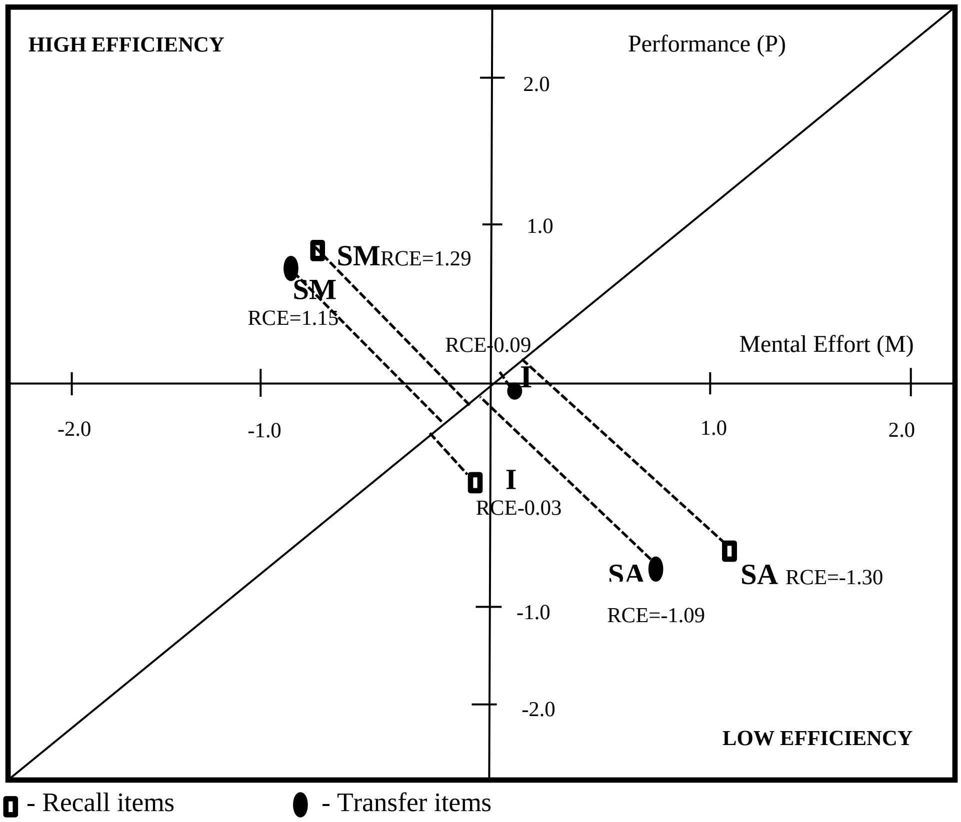


Figure 7.5: Experiment 1 relative condition efficiency representations for three training conditions
SA=split-attention-Group 1, I = integrated-Group 2, and SM=self-managed-Group 3
RCE=Relative Condition Efficiency

In addition, the interaction pattern as depicted in Figure 7.6 below shows that the recall and transfer efficiency is proportionally similar on both recall and transfer items with the self-managed group exhibiting superior instructional efficiency, followed by the integrated group, which supports the hypothesis that those students in the self-managed group would perform better than the conventional split-attention group.

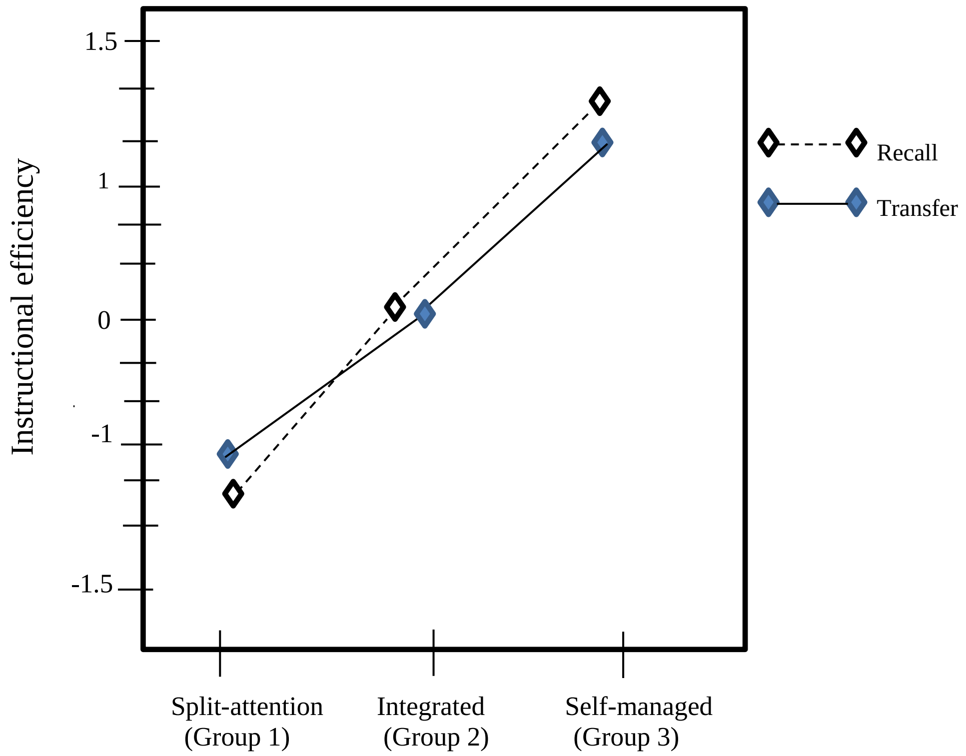


Figure 7.6: Experiment 1 instructional efficiency for recall and transfer as a function of instructional formats

7.1.6.9 Guidance Compliance

Results of the compliance measures indicated that 40 of the 42 participants (95%) followed the guidance about how to self-manage split attention. Compliance concerns to the student's use of the guidance accompanying the learning material for Group 3. Students participating in the study were considered "compliant" if they performed at least one of the tasks provided which were: highlighting material with a highlighter, using arrows to link text and diagram, underlining material, or drawing circles on key words with a pencil or pen.

As shown in Table 7.10 the most common strategy used by the participants (86%) was highlighting, underlining or numbering. The second most used strategy was drawing an arrow to link it to its corresponding place on the diagram. Only 36% of the participants drew a circle around the information.

Table 7.10: *Strategies used by Group 3 participants*

No.	Task	No. of participants	Percentage
1	Draw a circle around the information	15	36%
2	Draw an arrow to link it to its corresponding place on the diagram	24	57%
3	Highlight, underline or number	36	86%

The use of at least one of these tasks is seemingly quite useful in understanding the instructional material. The level at which these tasks were conducted suggests that full utilisation of the guidance contributed to higher performance scores.

7.2 Summary and Discussion of Experiment 1

In Experiment 1, the finding of significantly higher transfer performance scores by students in the self-managed group compared to those in the conventional split-attention group was clearly evident. The superiority of the self-managed group might have resulted from the implementation of the guidance on how to integrate text and diagrams before learning the instructional material. The requirement to mentally integrate text with relevant aspects of the diagram by the split-attention group which had no guidance may have contributed to poor performance by the split-attention group. The results of performance scores on transfer items are similar to findings by Chandler and Sweller (1991; 1992), Florax and Ploetzner (2010), Roodenrys et al. (2012), Tindall-Ford et al. (2015), and Ward and Sweller (1990). Such superior performance had been demonstrated, for example by Roodenrys et al. (2012), with Australian students studying educational psychology, by showing slightly increased accuracy of students in the self-management group over the integrated group during the transfer although not during the recall tasks.

Students in the self-management group performed significantly better than students in the split-attention group in the recall tasks. The study showed a strong self-management effect when compared with the split-attention format which had not been observed in any other previous study. Possible reasons for this include the fact that many studies conducted on the self-management effect involved small sample sizes and short treatment time lengths. Hence the current results strongly suggest that providing students with guidance of reorganising the material, using arrows, highlighting and placing material in proximity with diagrams prior to learning new content would result in effective learning under the self-managed format as compared to the other two instructional formats. Thus the findings of Experiment 1 were consistent with all the hypothesised treatment effects.

For compliance measures, more than 94% followed the guidance offered. The performance of the self-management group may be attributed to the guidance given during the learning phase. The guidance to the self-management group improved performance across the two performance measures of recall, transfer and low cognitive load.

7.3 Experiment 2: Replication of Experiment 1, Test Split-attention and Transfer of Self-management of Cognitive Load Skills

7.3.1 Introduction

The purpose of Experiment 2 was to examine if the skills of self-management were transferable to a new learning domain. In addition, the aim of Experiment 2 was to see if we could replicate both the split-attention effect observed in Experiment 1 as well as test the transference of skills to a new learning domain. The target population and sample membership was the same as in Experiment 1. The participants were the same 123 subjects as in Experiment 1.

7.3.2 Materials

The materials were similar to Experiment 1, but the content of the instructional materials was different from Experiment 1. For Experiment 2, the learning materials explained formulas for ratios and ways of computing them as presented in an accounting textbook (Weygandt et al., 2010:783-785). The sets of instructional material were formatted exactly the same as in Experiment 1 for use by the split-attention, integrated and self-management groups. For the self-management group, no guidance was given. The students were expected to utilise the self-management techniques they gained from Experiment 1.

7.3.3 Rating of Mental Effort

As in Experiment 1, Paas' (1992) and Paas et al.'s (2003) 9-point subjective cognitive load rating scale was used to measure levels of cognitive load (see Appendix B). The rating scale was provided after the learning phases and after each test question. Again the rating scale was illustrated and explained to the participants before beginning the experiment.

7.3.4 Procedure

The material was presented to each group and followed the second and third phase described in Experiment 1. This experiment included two phases conducted during the teaching of financial accounting to first-year university students. First, the participants were requested to review their materials for 10 minutes. This was during the learning phase. Soon after this, the participants were given a test that was on a single sided A4 booklet. The test contained recall and transfer test items. The participants were given 45 minutes to complete the test. The nature of the instructional conditions used was identical to those used in Experiment 1, with two exceptions: the content used for both recall and transfer tasks was different; and, during Experiment 2, the self-management group was not given guidance on how to self-manage. They were expected to apply the

skills they learned in Experiment 1. The recall items required participants to rewrite the accounting ratios. An example of a recall question in the test was:

List the formulas used to calculate the following ratios

Return on equity ratio: ………………………………………………………….

Return on assets ratio:..………………………………………………………….

Profit margin ratio:……………………………………………………………

An example of a transfer question was: What do the ratios reveal about the performance of B and W Ltd?

Mental effort ratings were solicited from participants after the learning phase and after attempting every question. Participants wrote on the blank spaces immediately below the questions when answering. The researcher collected all the test booklets soon after the students completed the tasks.

7.3.5 Results and Discussion

To investigate the effect of instructional formats on perceived amount of mental effort, recall and transfer test performance, a one-way, between-subjects ANOVA was conducted. The data for Experiment 2 was analysed with code 1, 2, and 3 representing the split-attention, integrated and self-managed conditions respectively. As in Experiment 1, in cases of significant F tests, post-hoc comparisons using Tukey contrasts were conducted, and the statistical significance level was set at .05 ($p < .05$).

In the sections that follow, results of one-way analyses of variance (ANOVAs) for Experiment 2, showing the mean and standard deviations are presented as follows:

- rating for mental effort invested in the learning phase
- recall test performance scores
- ratings of mental effort invested in the recall test phase
- transfer test performance scores
- ratings of mental effort invested in the transfer test phase
- relative efficiency of instructional conditions.

7.3.5.1 Mental Effort Ratings in the Learning Phase

The means and standard deviations for learning phase of mental effort ratings are shown in Table 7.11. Results from the one-way ANOVA for mental effort invested in the learning phase indicated significant differences across the three formats, ($F(2, 120) = 39.04$, $p < 0.05$, effect size (partial $\eta^2 = 0.394$)). Consistent with predictions, there were large and significant between-group differences on mean mental effort rating on learning results. Tukey post-hoc tests for learning phase revealed that the mental effort was statistically significant with the self-managed group recording the lowest cognitive load (3.62 rating, $p < 0.05$) compared to the integrated format group (4.73 rating, $p < 0.05$), $d = 0.55$, and the split-attention format group (7.17 rating, $p < 0.05$), $d = 1.99$. Tukey post-hoc tests also revealed that the integrated format group reported a significantly lower level of perceived cognitive load when compared to the split-attention format group, $d = 1.32$, indicating a large effect size (Cohen, 1988).

Table 7.11: *Experiment 2 means and standard deviations for learning phase mental effort ratings*

	Learning phase	
Instructional format	Mean rating (Maximum rating = 9)	Standard deviation
Split-attention (n=41)	7.17	1.64
Integrated (n=40)	4.73	2.04
Self-managed (n= 42)	3.62	1.91

Note. Actual score ranges were 0 to 9 for cognitive load.

7.3.5.2 Performance Measures

Table 7.12 shows the means and standard deviations of the performance scores as a function of instructional format. The one-way ANOVA for transfer questions also demonstrated a significant main effect of group ($F(2, 120) = 60.721$, $p < 0.05$, effect size (partial $\eta^2 = 0.503$)). Post-hoc comparisons using Tukey contrasts showed that the

self-managed group performed significantly better than both the split-attention group, *d* = 2.3, and the integrated group, *d* = 1.23. The integrated group also performed significantly better than the split-attention group, *d* = 1.25.

Table 7.12: *Experiment 2 means and standard deviations for recall and transfer test scores*

	Recall		Transfer	
Instructional format	Mean	SD	Mean	SD
Split-attention (n=41)	5.66	1.83	4.49	1.93
Percentage correct	51.46		40.71	
Integrated (n=40)	7.05	1.65	6.78	1.70
Percentage correct	64.28		61.73	
Self-managed (n= 42)	9.57	1.29	9.14	2.11
Percentage correct	87.14		83.21	

Note. Actual raw score ranges were 0 to 11 for recall, 0 to 11 for transfer; SD = Standard deviation.

7.3.5.3 Mental Effort Rating on Instruction

Means and standard deviations for recall and transfer mental effort are shown in Table 7.13. A one-way ANOVA was conducted on the instructional rating (of mental effort required) that the participants were asked to provide after answering every question. Results indicated a significant effect between-groups for recall items ($F(2, 120) = 75.477$ $p < 0.05$, effect size (partial $\eta^2 = 0.557$)).

Table 7.13: *Experiment 2 mental effort rating means and standard deviations for test phase based on one-way ANOVA under the three instructional conditions*

	Recall		Transfer	
Instructional format	Mean rating	SD	Mean rating	SD
Split-attention (n=41)	6.56	1.66	6.05	1.38
Integrated (n=40)	4.63	1.44	3.89	1.30
Self-managed (n= 42)	2.71	1.13	2.33	1.21

Note. Actual mental rating score ranges were 0 to 9 for cognitive load; SD = Standard deviation.

Post-hoc comparisons using Tukey contrasts showed that the self-managed group reported lower mental effort (2.71 rating, $p < 0.05$) than both the split-attention group (6.56 rating, $p < 0.05$), d =2.71, and the integrated group (4.63 rating, $p < 0.05$), d =1.48. The integrated group had a significantly lower mental effort than the split-attention group, d = 1.24.

One-way ANOVA for transfer test items revealed a significant main effect of group ($F(2, 120) = 85.925$, $p < 0.05$, effect size (partial $\eta^2 = 0.589$)). Post-hoc comparisons using Tukey contrasts showed that the self-managed group reported lower mental effort (2.33 rating, $p < 0.05$) than the split-attention group (6.05 rating, $p < 0.05$), d = 2.86 and the integrated group (3.89 rating, $p < 0.05$), d = 1.24. The integrated format group (3.89 rating, $p < 0.05$) reported significantly lower mental effort than the split-attention format group (6.05 rating, $p < 0.05$), d = 1.61.

7.3.5.4 Relative Efficiency of Instructional Conditions

A similar approach as in Experiment 1 was used to determine the level of instructional efficiency for the three groups. The performance scores and the mental effort ratings by the participants were first standardised. Again the group mean z-scores are compared through a one-way analysis of variance (ANOVA), tabulated and presented as shown below. Table 7.14 shows the means and standard deviations of the performance

efficiency of recall and transfer tasks for Experiment 2 under the three instructional conditions.

One-way ANOVA results showed a significant effect between groups for recall items ($F(2, 120) = 83.227$, $p < 0.05$, effect size (partial $\eta^2 = 0.581$)). Tukey post-hoc tests revealed a significant difference in which the integrated group reported higher relative instructional efficiency than the split-attention group ($F(2, 120)$ $p < 0.05$). In addition, the self-managed group had a significantly higher relative instructional efficiency than the split-attention group ($F(2, 120)$ $p < 0.05$). The self-managed group also had a significantly higher relative instructional efficiency than the integrated group ($F(2, 120)$ $p < 0.05$).

Table 7.14: *Experiment 2 means and standard deviations of instructional efficiency*

	Level of relative instructional efficiency			
	Recall		Transfer	
Instructional format	Mean	SD	Mean	SD
Split-attention (n=41)	-1.20	1.05	-1.31	0.69
Integrated (n=40)	-0.13	0.89	0.05	0.57
Self-managed (n= 42)	1.30	0.67	1.22	0.81

Note. SD = Standard deviation.

A one-way ANOVA for the transfer test items showed a significant main effect of group ($F(2, 120) = 135.267$, $p < 0.05$, effect size (partial $\eta^2 = 0.693$)). Post-hoc comparisons using Tukey contrasts showed statistically significant differences among all the groups. The integrated group showed higher instructional efficiency than the split-attention group ($F(2, 120)$ $p < 0.05$). The self-managed group had significantly higher

instructional efficiency than both the split-attention group ($F(2, 120)$ $p < 0.05$) and the integrated group ($F(2, 120)$ $p < 0.05$).

7.3.5.5 Relative Condition Efficiency, Additional Analyses

The means of the standardized scores for recall are tabulated below.

Table 7.15: *Experiment 2 performance, effort, and relative condition efficiency means for recall*

	Level of rating on recall test		
Instructional format	Performance	Effort	Relative condition efficiency
Split-attention (n=41)	- 0.78	0.91	- 1.20
Integrated (n=40)	- 0.17	0.01	- 0.13
Self-managed (n= 42)	0.93	- 0.90	1.29

The findings revealed that the self-managed group had a positive relative condition efficiency value, whereas the split-attention and integrated groups had negative efficiency values. This suggests that the self-managed group had higher performance efficiency than the split-attention and integrated groups on the recall tasks.

7.3.5.6 Graphical Illustration of the Relative Condition Efficiency for Recall

Table 7.15 above shows that the efficiencies of both the split-attention group and the integrated group are negative suggesting a degree of inefficiency. To further demonstrate these differences, a visual illustration is shown below in Figure 7.7. The differences between the self-managed group, split-attention group and integrated group can be seen on either the low instructional efficiency or high instructional efficiency side. As demonstrated in Chapter 6, the standardised recall scores for performance and effort (as shown in Table 7.15) were plotted in a coordinate system as dots representing the instructional condition (see Figure 7.7) for the purpose of revealing the level of efficiency.

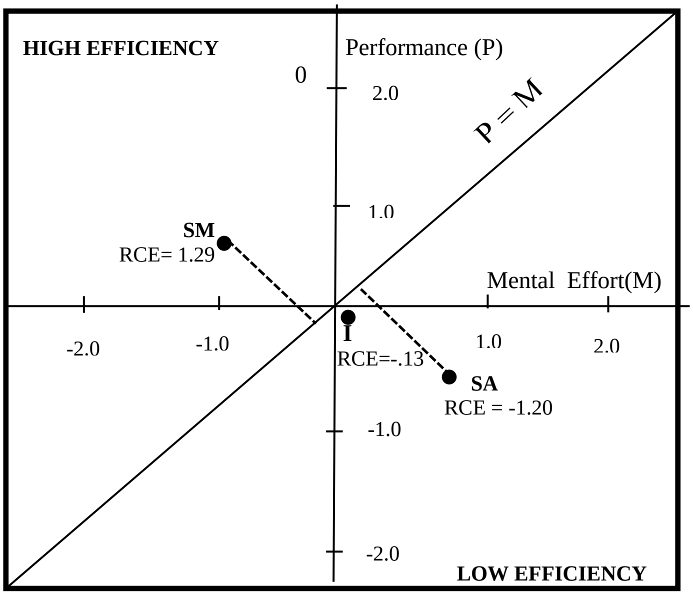


Figure 7.7: Experiment 2 relative condition efficiency representation for three training conditions
SA=split-attention-Group 1, I = integrated-Group 2,and SM=self-managed-Group 3
RCE=Relative Condition Efficiency

Figure 7.7 gives a z-score for performance, P, a z-score for effort, R, which are represented on the Cartesian axes of effort (horizontal) and performance (vertical). Specific points in this coordinate system refer to performance z-scores and related mental effort z-scores of experimental conditions. Instructional Efficiency (E) is then established by the perpendicular distance from each of these dots to the diagonal P = M line.

As shown in Figure 7.7, the efficiencies of the split-attention and integrated participants are below the Performance – Mental Effort line. Contrary to the split-attention and integrated participants, the self-managed participants were above the Performance – Mental Effort line thus demonstrating a substantial efficiency in the transfer questions. However, when comparing the split-attention and integrated groups, the integrated group seems to be far more instructionally efficient. The extent of the differences among the groups is further illustrated by Figure 7.8 below which illustrates the relationship between instructional formats and the respective efficiency. Figure 7.8 shows that the

relative instructional efficiency for the self-managed group was higher than it was for the split-attention group and integrated group.

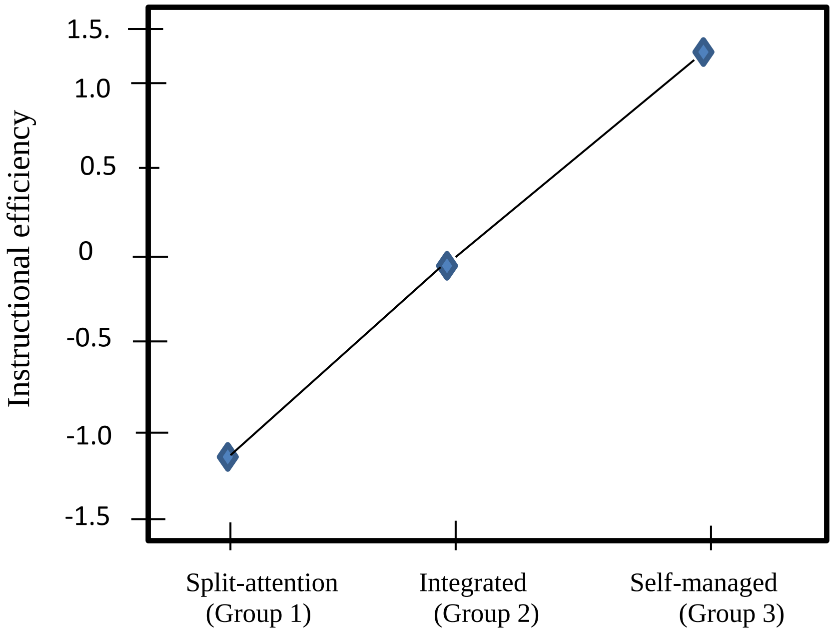


Figure 7.8: Experiment 2 instructional formats and instructional efficiency.

The transfer means of the standardized scores in Table 7.16 were plotted as shown in Figure 7.10. As can be seen in Figure 7.10, the efficiencies of both the split-attention and integrated group participants are relatively negative, though the integrated group was more efficient. The self-management participants demonstrated substantial efficiency in the transfer questions.

Table 7.16: *Experiment 2 performance, effort, and relative condition efficiency means for transfer*

	Level of rating on transfer test		
Instructional format	Performance	Effort	Relative condition efficiency
Split-attention (n=41)	-0.86	0.98	-1.31
Integrated (n=40)	-0.02	-0.09	0.05
Self-managed (n= 42)	0.86	-0.87	1.22

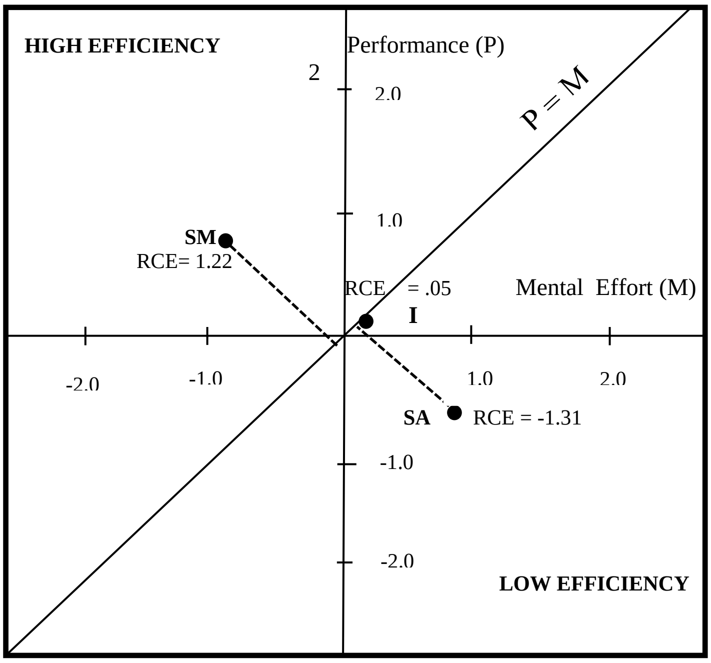


Figure 7.9: Experiment 2 relative condition efficiency representation as a function of three training conditions

SA=split-attention-Group 1, I = integrated-Group 2, and SM=self-managed-Group 3
RCE=Relative Condition Efficiency

Figure 7.9 gives a graphic presentation of the relative condition efficiency of the transfer tasks for each instructional group. The relative condition efficiencies of both split-attention and integrated groups are negative and below the Performance (P) - Mental effort (M) line. This suggests that only the self-managed group demonstrates substantial relative condition efficiency in the transfer questions since it is above the Performance (P) - Mental effort (M) line. The integrated format group was relatively more efficient than the split-attention format group.

The extent of the differences among the groups is better illustrated by Figure 7.10 which demonstrates the relationship between instructional formats and the respective efficiency. The relative instructional efficiency for the self-managed group was higher than it was for the split-attention and integrated groups.

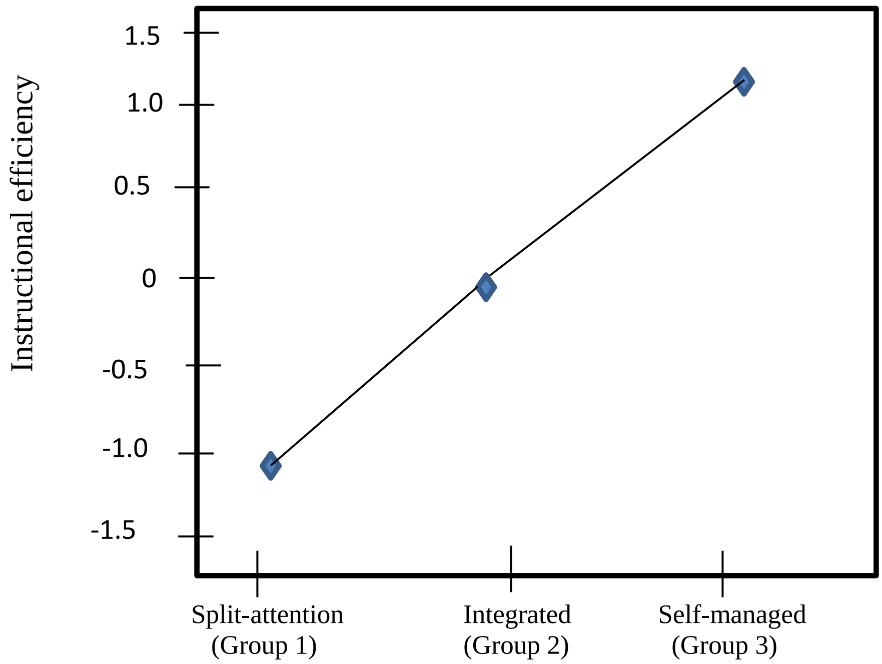


Figure 7.10: Instructional formats and instructional efficiency

7.3.5.7 Overall Comparison of Recall and Transfer Instructional Condition Efficiency for Experiment 2

The mean overall instructional efficiency for recall items and transfer items per experimental group is shown in Figure 7.11. The diagram demonstrates the similarities obtained on the instructional efficiency of both recall and transfer.

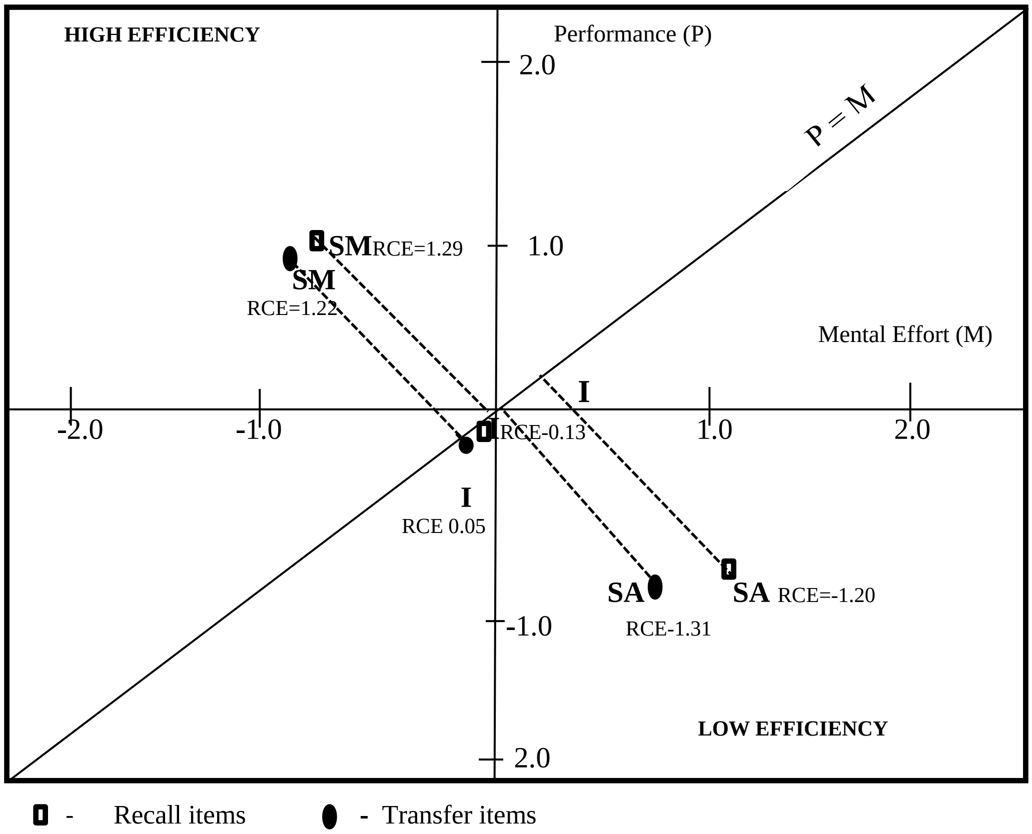


Figure 7.11: Relative condition efficiency representations for three training conditions
SA=split-attention-Group 1, I = integrated-Group 2, and SM=self-managed-Group 3
RCE=Relative Condition Efficiency

In addition, the interaction pattern, depicted in Figure 7.12, suggests that the recall and transfer efficiency is proportionally similar with self-management exhibiting superior instructional efficiency, followed by the integrated group, which supports the hypothesis that those students in the self-managed group would outperform the conventional split-attention group in performance measures due to the guidance about self-managing mental effort as they were not required to split their attention between the text and diagram.

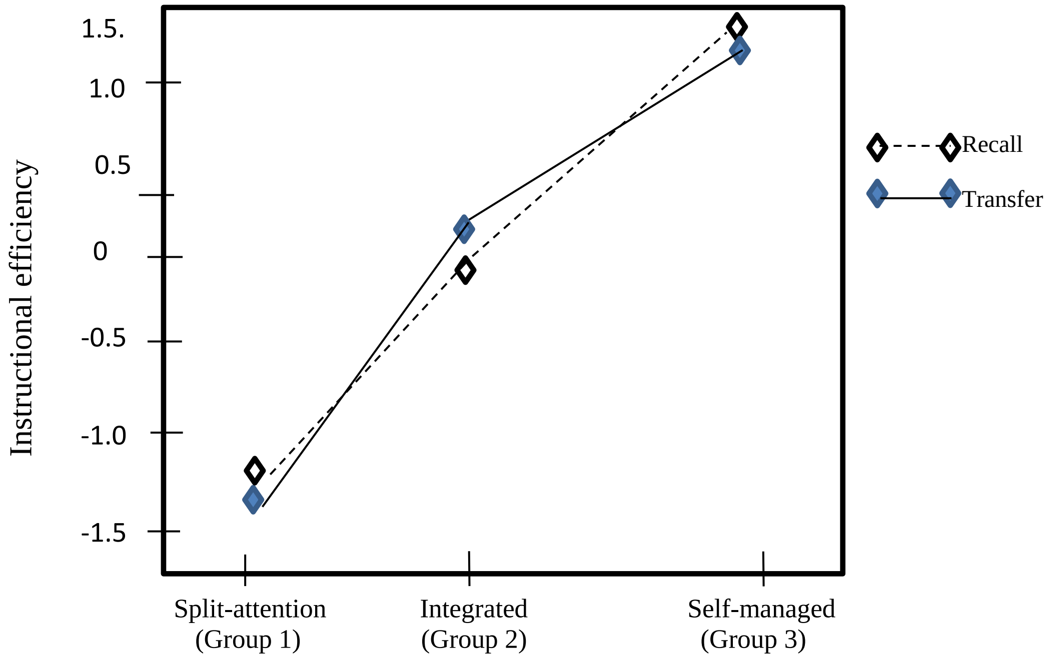


Figure 7.12: Instructional formats and instructional efficiency for recall and transfer.

7.3.5.8 Guidance Compliance

Results of the compliance measures for Experiment 2 indicated that 41 of the 42 participants (98%) followed the guidance about how to self-manage split attention. Similar to Experiment 1, participants were considered “compliant” if they performed at least one of the tasks provided which were highlighting material with a highlighter, using arrows to link text and diagram, underlining material, or drawing circles around key words with a pencil or pen.

As shown in Table 7.17 the most common strategy used by the participants (90%) was highlighting, underlining or numbering. The second most used strategy was drawing an arrow to link it to its corresponding place on the diagram. Only 43% of the participants drew a circle around the information.

Table 7.17: *Strategies used by Group 3 participants*

No	Task	No. of participants	Percentage
1	Draw a circle around the information	18	43%
2	Draw an arrow to link it to its corresponding place on the diagram.	28	67%
3	Highlight, underline or number	38	90%

7.3.5.9 Summary and Discussion of Experiment 2

Experiment 2 was designed to follow up on the results observed in Experiment 1 and test whether participants would transfer self-management skills to new and different split-attention instructional materials. If there is skills transfer, would this lead to a reduction in extraneous load and therefore enhance performance by the self-management group?

Students in the self-management group demonstrated higher performance than students in the split-attention group for both recall and transfer tasks. The participants in the self-managed group self-managed before attempting to learn the materials which improved their performance in relation to test items. Participants in the integrated and split-attention groups who learned the same material but had no self-management knowledge performed worse that the self-managed group across all performance measures, and the integrated group had higher performance scores than the split-attention group.

As expected, in Experiment 2, students in the self-managed instructional format group reported lower perceived cognitive load than students in the integrated format group. In turn students in the integrated format group reported lower perceived cognitive load than students in the split-attention format group. Apparently the processes required to work during the test phase demanded different amounts of mental effort in all

conditions. When the data are differentiated for recall and transfer, the results still revealed the same tendency with the self-management group reporting the lowest level of cognitive load.

7.4 General Discussion

The major finding from this study relates to the students' abilities to learn to manage cognitive load created by instructional material that requires them to split their attention between diagram and text. As a precursor to demonstrating the self-management skills, it was necessary to demonstrate that the accounting instructional materials do indeed demonstrate such split-source format and that this has a negative effect on learning. Both studies presented in this thesis showed that when split attention was managed by students by integrating text and diagrams (e.g., Chandler & Sweller, 1991; 1992; Mayer & Moreno, 2002; van Bruggen et al., 2002), they consistently outperformed those in the split-attention and integrated groups.

The results of Experiment 1 showed significant differences across the three groups, self-management, split-attention and integrated, in the recall and transfer test items. Further significant differences were reported in mental effort ratings. Cognitive load theory would suggest that students would be able to record more accurate responses when text and diagrams are integrated and even better performance when students self-manage the integration of text and diagrams. Experiment 1 revealed these differences. Students in the split-attention group performed worse than the self-managed and integrated groups in both the recall and transfer tasks. This was probably caused by the split-attention group referring to multiple sources of text and diagrams. The self-managed group also performed significantly better than the integrated group. This finding possibly illustrates that students are appropriately integrating the text into the diagram in a manner which facilitates learning beyond having students simply study instructor-manipulated instructional material.

In Experiment 2, Experiment 1 was replicated in an effort to test the robustness of the split-attention effect and establish the transference of skills to a new learning domain. As expected, the split-attention effect was demonstrated. The integrated and self-managed groups performed better than the split-attention group. Further, in a novel situation, the self-managed group managed to transfer the skills learned in Experiment 1 to Experiment 2. This demonstrated a strong potential for students to apply self-management to new instructional material that they encounter. The results in Experiment 1 showed significant differences in reported perceived mental effort ratings. The perceived amount of mental effort invested during the recall and transfer items components of the study showed that it was higher for the split-attention group followed by the integrated group and then lastly the self-management group. The same pattern was revealed in Experiment 2.

The most interesting outcome to emerge from these studies is that the self-managed group did in fact transfer self-management skills to a novel task, leading to a reduction in extraneous load and therefore outperforming other groups. Consistent with expectations, across recall and transfer tasks, the self-managed group outperformed the split-attention and integrated groups, hence the results showed that indeed the transfer occurred.

A further explanation of the results is that the superiority of the self-management condition might have resulted from the comprehensive explanation of the steps they had to undertake before learning the instructional material. For example, by numbering, highlighting or underlining and using arrows to link text to the relevant aspects of the diagram, these procedures enhanced the students' learning. Since the students followed the recommended steps they had a better understanding of the learning materials. It is possible that this opportunity to self-manage the instructional material resulted in the acquisition of schemata causing the superior performance scores by the self-management group.

With regards to cognitive load, students in the self-management group exerted less mental effort than participants in the integrated and split-attention groups. This is in line with the hypotheses on mental effort (Hypothesis 4, 5 and 6) and the studies by Agostinho et al. (2014), Roodenrys et al. (2012) and Tindall-Ford et al. (2015). The analyses of the efficiency scores, which reflected the ratio between invested mental effort and performance, yielded similar results with the self-management group being more efficient than the other two groups. In order to determine efficiency, instructional effectiveness measures were calculated using Paas and Van Merriënboer's (1993, 1994) procedure. This allowed measures of cognitive load obtained by the participants' subjective mental effort ratings to be combined with performance measures. The results from both Experiment 1 and Experiment 2 showed the self-management group was highly effective, indicating relatively low cognitive load and higher performance whilst the other two (split-attention and integrated groups) were located in areas with lower relative effectiveness reflecting higher cognitive load and lower performance. Taken together, the results of Experiments 1 and 2 suggest first that the presence of split-attention has a negative effect on learning. Second, the self-management condition is far more superior in enhancing student performance. Specifically, the results suggest that when students self-manage split-attention, they perform better than split-attention or instructor-managed split-attention (integrated). However, it should be noted that compared to similar studies the sample size reported in the current thesis was relatively high which may have caused the effects to be well pronounced.

7.5 Chapter Summary

This chapter presented data of two studies involving three instructional design techniques and included discussion of the results. The experiments described in this chapter confirmed the hypothesis that a self-management format is more effective than a split-attention and an integrated format in the area of introductory accounting with undergraduate university students. The implications, limitations and suggestions for future studies are presented in Chapter 8.

Chapter 8: Implications of the Findings, Limitations and Suggestions for Future Research

8.1 Introduction

This chapter discusses the implications of the findings within the context of extant literature, limitations of the study and recommendations for future research.

8.2 Theoretical and Methodological Implications for Research in Cognitive Load Theory

As discussed in this thesis, the fundamental purpose of instructional design is to make an effective use of the available cognitive resources and also to achieve higher performance. The studies reported in the present thesis provide a first trend in this direction by reporting a significantly better performance in the self-management format group than in the split-attention and integrated format groups. The implications of this thesis are numerous, not only for split attention but also for other cognitive load effects.

As demonstrated, the self-management format requires significantly lower cognitive load on the student than the split-attention format. The evidence of a self-management effect in the area of introductory accounting adds to research into this effect in other learning domains like physical manipulation of digital materials (Agostinho, Tindall-Ford, & Bokosmaty, 2014; Agostinho et al., 2013; Tindall-Ford et al., 2015) and educational psychology (Roodenrys et al., 2012). These studies have shown consistent self-management effects as well.

Most previous research has largely focused on instructor-manipulated learning materials with expertise reversal effects (e.g., Blayney et al., 2010; Kalyuga et al., 2003), the worked example effect (e.g., Paas & Van Gog, 2006; Sweller, 2006), the split-attention effect (e.g., Ayres & Sweller, 2005; Chandler & Sweller, 1991; Clark et al., 2006; Florax & Ploetzner, 2010), the modality effect (e.g., Ginns, 2006; Goolkasian, Foos &

Eaton, 2009; Mayer, 2001, 2005), and the redundancy effect (e.g., Moreno & Mayer, 2002; Samur, 2012). By demonstrating the very effective consequences of self-management, this thesis suggests that CLT research may consider shifting focus away from “instructor-based” management toward “learner-based” management.

8.3 Instructional Implications for Instructors and Students

The results reported in the present study support the conclusion that learning instruction with emphasis on self-management of the instructional material is an appropriate alternative to other ways of mediating the undesirable consequences of split-attention. At the same time, caution is needed when undertaking this strategy since several studies have concluded that the self-management strategy has to be carefully implemented in order to enhance learning (e.g., Roodenrys et al., 2012; Tindall-Ford et al., 2015).

Many of the learning activities that novice undergraduate accounting students engage with in the classroom, whether related to reading, calculations, or other areas of studying accounting, impose considerable burdens on the limited capacity of working memory. These activities often require a student to hold in mind some information (for example, a text) while attempting to match with relevant parts of a diagram. This is something that cognitive load theory and this thesis argue is mentally challenging and may impede learning. Therefore instructors need to design instructional material that is already integrated; or, even more importantly, guide students with crucial information to self-manage by properly integrating relevant study material to facilitate learning.

8.3.1 How Students can Study Subjects in Schools and Universities

The studies reported in this thesis were conducted in a specific setting; however, the instructional implications may be wide-ranging. This is because self-management is designed to enable students to self-manage whatever instructional material they come across. The ability of the students to transfer the skills they learned to a new learning domain during Experiment 2 clearly illustrates this potential.

A majority of universities offer learning services that are accessible to both students and staff. These offer courses or workshops that assist in navigating the university environment. Generic skills training in CLT principles and self-management in particular can be offered to students and lecturers in these workshops. Such training can provide students with illustrations of split-attention material (and other CLT effects) which could enable them to first identify split-attention instructional material and then to manage it. These are practical skills that can be taught to students in a university setting.

Pioneer Advertising Agency	
Statement of Financial Position	
As at 31 October 2010	
ASSETS	$
Cash at bank	15,200
Accounts receivable	200
Advertising supplies	1,000
Prepaid insurance	550
Office equipment 5,000	
Less: Accumulated dep. (40)	4,960
TOTAL ASSETS	**$21,910**
LIABILITIES	
Notes payable	5,000
Accounts payable	2,500
Unearned revenue	800
Salaries payable	1,200
Interest payable	50
TOTAL LIABILITIES	**9550**
Owners' equity	
C.R. Hill, Capital	12,360
TOTAL LIABILITY AND OWNER'S EQUITY	**$21,910**

Assets = Liabilities + Equity

Figure 8. 1: Self-management of the Statement of Financial Position and the basic accounting equation using arrow
Source: Adapted from *Weygandt et al. (2010:140)*

An example of how students can self-manage material found in textbooks is presented in Figure 8.1. Most textbooks would have the basic accounting equation separately stated and explained from the Statement of Financial Position. A method using arrows to self-manage is presented in Figure 8.1.

While this study enables us to suggest ways in which instructors can help learners achieve greater success early in their undergraduate subjects it also assists learners to solve problems by manipulating instructional materials by themselves at any level of their studies. Students can be taught how to navigate through lectures, studying for examinations and various other learning activities using self-management skills as illustrated in Figure 8.3. And also most importantly, they must know when to apply the self-management skills. These skills are particularly useful for students when studying textbooks.

8.3.2 Instructors' Role in Guiding Students to Self-study Instructional Material

This study reinforces the importance for instructors not just to design material according to CLT principles but to present instructional formats in a way that students can easily navigate for self-management. Despite the potential revealed by these two experiments, for self-management to be successful, the onus still rests with the instructor to ultimately guide the students to manage the load. First, students need to be explicitly taught how to self-manage, and the reasons why self-managing text within a diagram enhances learning should be explained. The self-management of split-attention should not be regarded by the learner as a way of only physically moving the text to a diagram but also as a way to support understanding of the instructional material.

8.4 Instructional Implications for Textbook Writers

Numerous examples exist of instructional material not designed according to cognitive load theory principles in the area of introductory accounting. As illustrated in Chapter 2 of this thesis, students often encounter instructional material such as the statement of

financial position (balance sheet), which is a summary of the financial balances of a business organisation. Assets, liabilities and ownership equity are listed as of a specific date, such as the end of its financial year. The general format involves a diagrammatic representation of the three parts of a balance sheet: assets, liabilities and ownership equity with their associated categories and text below or above the diagrammatic representation.

Format of the balance sheet normally found in textbooks

BALANCE SHEET	
ASSETS	**Amount**
Cash at bank	XX
Accounts receivables	XX
Building	XX
TOTAL ASSETS	**XXXX**
LIABILITIES	**XX**
Accounts payable	XX
Mortgage payable	XX
TOTAL LIABILITIES	**XXXX**
NET ASSETS	**XX**
EQUITY	XX
XY, Capital	XX
TOTAL EQUITY	**XXXX**

Assets. Are resources controlled by an entity as a result of past events and from which future economic benefits are expected to flow to the entity. These economic benefits can be tangible (having physical characteristics) such as land buildings and equipment or intangible (assets without physical existence) such as legal claims, or patent rights.

Integrated format of the balance sheet

Balance Sheet		
ASSETS	**Amount**	**Assets** are resources controlled by an entity as a result of past events and from which future economic benefits are expected to flow to the entity. These economic benefits can be tangible (having physical characteristics) such as land buildings and equipment or intangible (assets without physical existence) such as legal claims, or patent rights.
Cash at bank	XX	
Accounts receivables	XX	
Building	XX	
TOTAL ASSETS	**XXX**	
LIABILITIES	**XX**	
Accounts payable	XX	
Mortgage payable	XX	
TOTAL LIABILITIES	**XXX**	
NET ASSETS	**XX**	
EQUITY	XX	
XY, Capital	XX	
TOTAL EQUITY	**XXX**	

Figure 8.2: Extract of the split-attention format and the integrated format of the balance sheet

An alternative instructional presentation would be to have the text embedded in the diagrammatic presentation which is referred to as integrated; and, as this study has shown, this would likely reduce the extraneous cognitive load and enhance learning. An illustration of an extract of a balance sheet normally found in textbooks is presented below. The text explaining the components of the balance sheet is presented in the balance sheet as shown in Figure 8.2.

Another conventional way of presentation, again with the balance sheet, is to visualise the balance sheet in the form of an equation. The equation explained within the text would be that total assets equals liabilities plus owners' equity. Examining the accounting equation in this way illustrates how assets were financed (by borrowing money, creating a liability or by means of owners' capital).

However, some accompanying balance sheets may not have the equation depicted, and students are usually forced to have a mental representation of the equation in their minds as they try to make sense of the assets in one section and the liabilities and net worth in the other section which would make the sections "balance".

Pioneer Advertising Agency	
Statement of Financial Position	
As at 31 October 2010	
ASSETS	
Cash at bank	$ 15,200
Accounts receivable	200
Advertising supplies	1,000
Prepaid Insurance	550
Office Equipment 5,000	
Less: Accumulated dep. (40)	4,960
TOTAL ASSETS	**$ 21,910**
LIABILITIES	
Notes payable	5,000
Accounts payable	2,500
Unearned revenue	800
Salaries payable	1,200
Interest payable	50
TOTAL LIABILITIES	**$ 9,550**
Owners' equity	
C.R. Hill, Capital	12,360
TOTAL LIABILITY AND OWNER'S EQUITY	**$21,910**

Figure 8.3: Statement of Financial Position found in an accounting textbook
Source: *Weygandt, Chalmers, Mitrione, Fyfe, Kieso, & Kimmel (2010:140)*

Figure 8.2 above illustrates this. Such type of presentation exerts an unnecessary load on working memory. These preliminaries to learning require self-management strategies such as teaching students appropriate linking, highlighting, and underlining techniques during their self-study. An example of a balance sheet with the basic accounting equation is presented in Figure 8.3 below.

	Pioneer Advertising Agency	
	Statement of Financial Position	
	As at 31 October 2010	
Assets	**ASSETS**	
	Cash at bank	$ 15,200
	Accounts receivable	200
	Advertising supplies	1,000
=	Prepaid Insurance	550
	Office Equipment 5,000	
Liabilities	Less: Accumulated dep. (40)	4,960
	TOTAL ASSETS	**$21,910**
	LIABILITIES	
	Notes payable	5,000
	Accounts payable	2,500
	Unearned revenue	800
+	Salaries payable	1,200
	Interest payable	50
	TOTAL LIABILITIES	**9550**
Equity	Owners' equity	
	C.R. Hill, Capital	12,360
	TOTAL LIABILITY AND OWNER'S EQUITY	**$21,910**

Figure 8.4: Integrated Statement of Financial Position

Source: Adapted from *Weygandt et al. (2010:140)*

8.5 Implications for Researchers and Theorists

8.5.1 The Effect of Self-management in a New Learning Domain

The unique results in this thesis relate to the transference of skills which was demonstrated in Experiment 2 by the self-managed group. Experiment 2 sought to establish whether participants, given a new set of materials, would transfer any skills regarding split-attention management. The self-managed group outperformed the split-attention and integrated groups on recall and transfer items. This superior performance was attained at the lowest cognitive load when compared with the other two groups.

Transfer is the ability to extend what one has learned in one context to new contexts. In some sense, the whole point of teaching students to self-manage accounting

instructional material is for them to be able to transfer what they have learned to a wide variety of contexts outside of what they have immediately understood. Yet the ability to transfer information or ideas is not a given. Quite often, information learned in a specific way, or in a particular context, does not transfer to other contexts. For example, students may memorise accounting concepts, but they often cannot apply the concepts to answer a question. Students may learn the accounting equation, but they do not know how to apply the accounting equation when they are confronted with a different kind of problem related to the accounting equation.

In most cases, students encountering new accounting material on their own will rarely have a manual telling them exactly what to do. Given the vast array of knowledge needed in accounting, the teacher's challenge is to determine the amount of material that can be taught really well that will allow learners to use that knowledge in the widest possible range of situations. Teaching students how to manipulate instructional material using self-management techniques has proved to be a possible way to enhance the transfer of knowledge. In this thesis, participants learned how to self-manage the instructional material while studying accounting materials on the accounting equation. They were able to transfer the skills they learned to new materials on ratio analysis. Thus students should be able to use the skills learned when studying other instructional material with evident split-attention.

8.5.2 Robustness of the Split-attention Effect

The first known evidence on the consequence of split-attention in the area of introductory accounting was revealed in this study. This unique result was obtained across all four different measurement areas (i.e., recall items and transfer items in Experiment 1, recall items and transfer items in Experiment 2). This major result was demonstrated by analysing the self-managed and integrated groups. These two groups can be categorised as having instructional materials designed in an integrated format. On the other hand, the split-attention group can be categorised as a non-integrated

format. In both experiments, students in the integrated and self-managed groups consistently performed better than those in the split-attention (non-integrated group). Significant results were found in both Experiments 1 and 2 for recall and transfer items. These studies revealed a split-attention effect in which students learned better when diagrammatic information was accompanied by textual information rather than when a diagram and text were presented separately. As indicated in the first paragraph, the robustness of the effect was evident on four different scenarios, recall and transfer items in Experiment 1 and recall and transfer items in Experiment 2.

These results extend previous research on split-attention effects (e.g., Chandler & Sweller, 1991, 1996; Clark & Mayer, 2008; Florax & Ploetzner, 2010; Ginns, 2006; Mayer, 2005; Roodenrys et al., 2012; Rose & Wolfe, 2000). For example, Chandler and Sweller (1991; 1992) found that by integrating formulas with diagrams, learners performed significantly better as they found it easier to integrate and process both forms of visual information. Even evidence of split-attention with audio/visual materials has been investigated. In a variety of experiments utilising learning material from geometry, Mousavi, Low and Sweller (1995) demonstrated that aurally presented text in combination with a visually presented geometry diagram improved learning compared to the conventional visual diagram and text presentation. They concluded that using more than one modality produced a positive effect similar to the effect of physically integrating separate sources of information. Tindall-Ford et al. (1997) examined the split-attention effect in electrical engineering and demonstrated that a combined audio text and visual diagram was superior to visually-based instructions. Numerous other studies which extend the split-attention effect in engineering, mathematics and computer science and related disciplines exist with none investigating the split-attention effect in the discipline of accounting (Mostyn, 2012). Yet, as noted by Mostyn (2012), incorporating CLT as part of introductory accounting instructional design offers a great opportunity to meet the needs of a variety of user populations in the discipline of accounting.

8.5.3 The Effect of Self-management when Compared to Instructor-manipulated Load

These findings relate to the comparison of the self-managed group and integrated group in both Experiment 1 and 2. For both Experiment 1 and 2, students in the self-managed instructional format group significantly outperformed students in the integrated format group on recall and transfer knowledge. Students in the integrated format group outperformed students in the split-attention format group on recall and transfer test items. This provides further evidence regarding the effectiveness of self-managed instructional design in the construction and automation of schemas for university undergraduate students. In particular, the results clarify the conditions producing the self-management effect by showing that the advantage of students self-managing instructional materials by studying text and corresponding diagrams that they have integrated enhances learning for both recall and transfer items.

8.5.4 The Interrelationship of Self-management and Cognitive Load

In both Experiments 1 and 2, there was a significant difference in cognitive load between students in each instructional format. The mental effort that students reported in the self-management condition is significantly less than the effort that the split-attention and integrated groups reported. This seems to be consistent with what Agostinho et al. (2014) and Roodenrys et al. (2012) have found. Moreover, the lower cognitive load was consistently obtained for both recall and transfer test items. Therefore the fact that these results reinforce the results of previous studies is interesting to note. The students in the self-managed group reported lower cognitive load and obtained higher scores. This can at least partly be explained by the fact that the students were explicitly taught how to self-manage, and the reasons why integrating text within a diagram would enhance learning were explained to them. An alternative explanation of the results is that the students in the self-managed condition not only physically moved text to diagram but had a certain level of expertise to purposefully move text, and in the process their understanding of the concepts improved. This expertise is gained through

learning self-management skills. A third possible explanation could be that since the sample size of the study was relatively large as compared to previous studies, the extent of the variation among the groups was also magnified.

In light of these findings, the results of the present thesis legitimise the conclusion that students' self-management is a suitable replacement to conventional split-attention instruction. It should also be noted that wholesale application of self-management is not appropriate. Effective self-management depends first on the absence of redundancy within the instructional material. Second, the effect may only apply to novice learners.

8.6 Limitations of the Current Thesis and Ideas for Future Research

8.6.1 Cognitive Load Measurement

There are a few important limitations of the studies presented in this thesis to note. The measurement of cognitive load presented a challenge within this thesis. That issue is not limited to this thesis and has been widely discussed in the cognitive load literature (Paas & Van Merriënboer, 1993; Sweller, 2010; Sweller et. al., 2011; Van Gog & Paas, 2008). Because the specific type of cognitive load was not directly measured, future research might attempt to determine the precise type of cognitive load reported by the students. Cognitive load theory's assumption that total cognitive load is comprised of intrinsic, extraneous, and germane load has meant that most researchers have to establish measurement techniques to differentiate between these three cognitive load components rather than only measuring the total cognitive load. In addition, non-cognitive factors (e.g., emotional stress) are confounded with these three cognitive load components.

Another limitation, again related to cognitive load measurement, is the time on task. The results suggest that both recall and transfer tasks were difficult enough to differentiate the three groups. However, although the results are consistent with cognitive load theory, it is not clear whether students participating in the studies took the time spent on the task into account when they ranked cognitive load. For example, what is not known

is whether a 3 on a 9–point rating scale for a student who worked for 10 minutes on a task is similar to a rating of 3 again on a 9–point rating scale for a student who worked on the task for 5 minutes.

In this thesis, a self-reporting scale was used to collect mental effort ratings. Instructional material had a rating scale at the end of the learning phase and at the completion of recall and transfer items (See Appendix B for details). The participants were required to indicate the level of cognitive load experienced during a task. Participants were asked to assess how easy or difficult they found the instructional phase or test items. Consistent with many previous studies participants were able to report efficiency ratings that coincided with the perceived level of difficulty of the test items (Mayer & Chandler, 2001; Pollock et al., 2002). The successful application of the rating scale may be attributed to the usage of the original Pass (1992) rating scale without any variations. Some studies have modified the original scale. Therefore, further studies may still need to be done to establish cognitive load measurement consistency and acceptability.

All of the above limitations related to the measurement of cognitive load are relevant. A reliable and sensitive measurement of cognitive load which is directly related to mental effort is critical and needs to be developed in order to determine the most effective instructional design which minimises cognitive load while enhancing learning.

8.6.2 Learning More Advanced Accounting Subjects

An important research question has to do with the relevance of these findings to more advanced accounting subjects. As previously discussed, "experts" do not benefit from and may indeed see their learning negatively affected by attempts to intervene in split attention designs (Kalyuga et al., 2012). Since accounting subjects are taught in a progressive way, with the sessions for each week providing a foundation for the next, and the first semester providing the basis for the second semester and so on until

completion of an accounting program, it would be interesting to investigate at what level students would be considered "experts" rather than novices. Is it after the completion of the first semester, year or two years of learning accounting? Research in this area could establish the extent to which self-management design principles could be encouraged during some stages of learning accounting but not during others.

8.6.3 Most Effective and Other Self-management Strategies

Another area for future research could be investigating the effectiveness of other strategies students can use to self-manage cognitive load. The experimental studies reported in this thesis investigated the efficacy of students' self-management of the split-attention on their learning materials by numbering, highlighting, underlining or using arrows to link text to the relevant aspects of a diagram. The techniques used in this thesis can be used to inform the development of a comparative analysis of the self-management techniques. Many other tools could be investigated to find efficient methods of guiding students to manage their cognitive load. This thesis used paper and pen based materials. However, as the use of technological and online learning platforms continue to flourish in educational settings, exploring the effects of various self-management instructions electronically will become even more important in the future. Students are gradually reading more and more information online, and investigations that provide empirical evidence to guide how students can self-manage cognitive load in online environments will be a valuable addition to CLT research.

8.6.4 Context of the Current Thesis

As previously discussed, this research relied on two studies based on a sample of undergraduate university students. The use of undergraduate university students in a typical classroom environment made it possible to examine the instructional format which enhanced learning. However, the conclusions from these studies are limited as there may be questions regarding the extent of generalisability to all undergraduate university students studying introductory accounting. The scale of further investigation

on self-management needs to be multifaceted and extensive since very few studies have investigated the self-management effect. In order to generate sustained arguments with regards to self-management in the discipline of accounting, there is a need for more experiments at other Zimbabwean and international universities.

8.7 Conclusion

The constraints that are imposed by the limitations on the capacity of our working memory are substantial and have deleterious consequences regarding learning. Fortunately, research has shown efficient methods of processing information that can preserve scarce storage capacity and increase the amount of information that can be stored. This research investigated one such efficient instructional strategy in order to counter the limitations of working memory.

The experiments in this thesis have demonstrated that it is possible to teach students to manage their own cognitive load. Most importantly, the studies have shown that such skills may be transferred to a new learning domain. This thesis has investigated a new and exciting direction of cognitive load theory. The future directions include further investigation of cognitive load measurement, in particular the measurement of each type of cognitive load.

There were key implications generated by this thesis for instructors, textbook writers, students, researchers and theorists. The findings relating to researchers and theorists can be categorised as follows:

1. The effect of self-management in a new learning domain
2. Robustness of the split-attention effect
3. The effect of self-management in all learning areas when compared to instructor-manipulated load
4. The inter-relationship of self-management and cognitive load

Future research could still investigate these claims within the context of a "self-management effect." The findings from this thesis show that, consistent with predictions, students learn best when they can manage the instructional materials. However, the "self-management effect" research is underdeveloped. Further extensive research to establish the self-management effect may be beneficial to cognitive load theory. Essentially, it is crucial that cognitive load effects are publicised for the benefit of learners to encourage self-management techniques useful in an age when cognitive demands are increasing at a very rapid pace in this information-driven world.

References

Abeysekera, I. (2008). Preferred learning methods: A comparison between international and domestic accounting students. *Accounting Education: An International Journal*, *17*(2), 187–198.doi:10.1080/0963928070 1220236.

Agostinho, S., Tindall-Ford, S., & Bokosmaty, S. (2014). Adaptive diagrams: A research agenda to explore how learners can manipulate online diagrams to self-manage cognitive load. In W. Huang (Ed.), *Handbook of Human Centric Visualization* (pp.529-550). Springer New York. doi:10.1007/978-1-4614-7485-2_21.

Agostinho, S., Tindall-Ford, S., & Roodenrys, K. (2013). Adaptive diagrams: Handing control over to the learner to manage split-attention online. *Computers & Education, 64*(2013), 52-62. doi:10.1016/j.compedu.2013.01.007.

AICPA (American Institute of Certified Public Accountants). (1999). *Core Competency Framework for Entry into the Accounting Profession* (AICPA, New York, NY). Available at http://www.aicpa.org/edu/corecomp.htm. Retrieved 20 November 2013.

Albrecht, W. S., & Sack, R. J. (2000). Accounting education: Charting the course through a perilous future. *Journal of Government Financial Management, 51*(1), 58-59.

Alexander, P. A. (2003). The development of expertise: The journey from acclimation to proficiency. *Educational Researcher, 32*(8), 10–14.doi:10.3102/0013189X0 320 08010.

Alexander D., & Nobes, C. (2010). *Financial Accounting: An International Introduction* (4th ed.). England: Pearson Education Limited.

Alexander, P. A., & Winne, P. H. (Eds.) (2006*). Handbook of Educational Psychology* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Alibali, R. S., & Siegler, M. (2004). *Children's Thinking* (4th ed.). Upper Saddle River, N.J.: Pearson Education/Prentice Hall.

Almer, E. D., Jones, K., & Moeckel, C. L. (1998). The impact of one-minute papers on learning in an introductory accounting course. *Issues in Accounting Education 13*(3), 485–495.

Amernic, J. H., & Beechy, T. H. (1984). Accounting students' performance and cognitive complexity: some empirical evidence. *The Accounting Review, 59* (2), 300-313.

Amernic, J. H., & Enns, R. J. (1979). Levels of cognitive complexity and the design of accounting curriculum. *The Accounting Review, LIV*(1), 133-146.

Atkinson, R.C., & Shiffrin, R. M. (1968). Human Memory: A proposed system and its control processes. In K.W. Spence (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory* 2 (pp. 89–195). New York: Academic Press.

Austin, K. A. (2009). Multimedia learning: Cognitive individual differences and display design techniques predict transfer learning with multimedia learning modules. *Computers & Education*, *53*(4), 1339–1354. doi:10.1016/j.compedu.2009.06 .017.

Ayres, P. (2006). Using subjective measures to detect variations of intrinsic cognitive load within problems. *Learning and Instruction, 16*(5), 389-400. doi:10.1016/ j.learninstruc.2006.09.001.

Ayres, P., & Paas, F. (2009). Interdisciplinary perspectives inspiring a new generation of cognitive load research. *Educational Psychology Review, 21*(1), 1-9. doi:10.1007/s10648-008-9090-7.

Ayres, P., & Paas, F. (2012), Cognitive load theory: New directions and challenges. *Applied Cognitive Pschology, 26*(6), 827–832. doi:10.1002/acp.2882.

Ayres, P., & Sweller, J. (2005). The split-attention principle in multimedia learning. In Mayer, R. (Ed.), *Cambridge Handbook of Multimedia Learning* (pp. 135—146). Cambridge University Press. doi:10.1017/CBO9780511816819.009.

Barbera, M. (1996) Management accounting futures. *Charter*, 67(11), 66-68.

Baddeley, A. D. (2000). The episodic buffer: a new component of working memory? *Trends. Cogn. Sci., 4*, 417–23.doi:10.1016/S1364-6613(00)015 38-2.

Baddeley, A. D. (2010). Working memory. *Current Biology, 20*(4), 136-140. doi:10.1016/j.cub.2009.12.014.

Baddeley, A. D. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology, 63*(1), 1-29.doi:10.1146/annurev-psych-120710-100422.

Baddeley, A. (1992). Working memory. *Science, 255*(5044), 556-559. doi: 10.1126/ science.736359.

Baddeley, A. D. (1986). *Working Memory*. New York: Oxford University Press.

Baddeley, A.D., & Hitch, G. (1974). Working memory. In G.H. Bower (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory* (Vol. 8, pp. 47–89). New York: Academic Press.

Banikowski, A. K., & Mehring, T. A. (1999). Strategies to enhance memory based on brain-research. *Focus on Exceptional Children, 32*(2), 1-16.

Barrouillet, P., Bernardin, S., Portrat, S., Vergauwe, E., & Camos, V. (2007). Time and cognitive load in working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(3), 570 - 585.

Bashir, T. H. (2000). Accounting instruction using the open learning approach. *Journal of Accounting Education 18,* (Summer), 229–240.doi:10.1016/ S0748-5751(00)00015-4.

Baxter, G. P., & Glaser, R. (1998), Investigating the cognitive complexity of science assessments. *Educational Measurement: Issues and Practice, 17*, 37–45. doi: 10.1111/j.1745-3992.1998.tb00627.x.

Bouwman, M.J. (1998). *Using Technology to Improve Student Learning in Accounting: a Research Agenda* (Working Paper). University of Arkansas.

Borja, P. M. (2003). So you've been asked to teach principles of accounting. *Business Education Forum, 58*(2), 30-32.

Burnett, S. (2003). The future of accounting education: A regional perspective. *Journal of Education for Business, 78*(3), 129-35. doi:10.1080/088 32320309599709.

Blackstaff, M. (2006). *Finance for IT Decision Makers: a Practical Handbook for Buyers, Sellers and Managers*. BCS, The Chartered Institute for IT.

Blanthorne, C., Bhamornsiri, S., & Guinn, R. E. (2005). Are technical skills still important? *The CPA Journal*. Retrieved fromhttp://www.nysscpa.org/ printversions/cpaj/2005.

Blayney, P., Kalyuga, S., & Sweller, J. (2010). Interactions between the isolated-interactive elements effect and levels of learner expertise: experimental evidence from an accountancy class. *Instructional Science, 38*(3), 277-287. doi:10.1007/s11251-009-9105-x.

Blayney, P., Kalyuga, S., & Sweller, J. (2015). The impact of complexity on the expertise reversal effect: experimental evidence from testing accounting students, *Educational Psychology: an International Journal of Experimental Educational Psychology*. doi:10.1080/01443410.2015.1051949.

Bloemhof, B., & Christensen H. J. (2013). *Active Learning Strategies in Introductory Financial Accounting Classes*. Toronto: Higher Education Quality Council of Ontario.

Boyd, D. T., Boyd, S. C., & Boyd, W. L. (2000). Changes in accounting education: Improving principles content for better understanding. *Journal of Education for Business, 76*(1), 36-42.doi:10.1080/08832320009599048.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, Mind, Experience, and School*. Washington, D.C. National Academy Press.

Bratfisch, O., Borg, G., & Dornic, S. (1972). *Perceived Item-difficulty in Three Tests of Intellectual Performance Capacity* (Rep. No. 29). Stockholm, Sweden: Institute of Applied Psychology.

Braver, T. S., Cohen, J. D., Nystrom, L. E., Jonides, J., Smith, E. E., & Noll, D. C. (1997). A parametric study of prefrontal cortex involvement in human working memory. *Neuroimage, 5*, 249–62.doi:10.1006/nimg.1996.0247.

Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction*. Boston: Pearson.

Bruning, R. H., Schraw, G. J., Norby, M. N., & Ronning, R. R. (2004). *Cognitive Psychology and Instruction* (4th ed.). Upper Saddle River, NJ: Pearson.

Brünken, R., Plass, J. L., & Leutner, D. (2003). Direct measurement of cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 53-61.doi:10. 1207/S15326985EP3801_7.

Brünken, R., Plass, J. L., & Leutner, D. (2004). Assessment of cognitive load in multimedia learning with dual-task methodology: Auditory load and modality effects. *Instructional Science, 32*(1-2), 115–132.doi:10.1023/B:TRUC.00000218 12.96911.c5.

Buettner, R. (2013). Cognitive workload of humans using artificial intelligence systems: Towards objective measurement applying eye-tracking technology. In KI 2013: *Advances in Artificial Intelligence* (pp. 37-48). Berlin Heidelberg: Springer.

Bunch, Y., & Lloyd, R. E. (2006). The cognitive load of graphic information. *The Professional Geographer, 58* (2), 209–220.doi:10.1111/j.14679272.2006.00527. x.

Bunting, M., Cowan, N., & Scott Saults, J. (2006). How does running memory span work?. *The Quarterly Journal of Experimental Psychology, 59*(10), 1691-1700. doi:10.1080/17470210600848402.

Caine, R. N., & Caine, G. (1997). Education on the edge of possibility. *Association for Supervision and Curriculum Development*, Alexandria, VA.

Carlson, R., Chandler, P., & Sweller, J. (2003). Learning and understanding science instructional material. *Journal of Educational Psychology*, *95*(3), 629-640.

Carpenter, S. K. (2012). Testing enhances the transfer of learning. *Current Directions in Psychological Science, 21*(5), 279-283. doi:10.1177/096372 14124 52728.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction, 8*(4), 293-332. doi: 10.1207/s1532690 xci0804_2.

Chandler, P., & Sweller, J. (1992).The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology*, *62*(2), 233–246.

Chandler, P., & Sweller, J. (1996). Cognitive load while learning to use a computer program. *Applied Cognitive Psychology, 10*(2), 151-170. doi: 10.1002/(SICI) 1099-0720(199604)10:2<151::AID-ACP380>3.0.CO;2-U.

Chase, W.G., & Simon, H. A. (1973). Perceptions in chess. *Cognitive Psychology, 4*(1), 55-81.

Chen, T. T. (2012). Framework governing the teaching of introductory accounting: A survey of acceptability at Hong Kong universities. *Educational Research Journal, 27*(1/2), 51-95.

Chi, M. T. H., Bassock, M., Lewis, R., Reimann, P., & Glaser, R., (1989). Self explanations: How students study and use examples in learning to solve problems. *Cognitive Science 13*(2) 145-182.doi:10.1207/s15516709 cog1302_1.

Chinnappan, M., & Chandler, P. (2010). Managing cognitive load in the mathematics classroom. *Australian Mathematics Teacher, 66*(1), 5-11.

Christensen Hughes, J., & Mighty, J. (2010). Practices of convenience: Teaching and learning in higher education. In J. Christensen Hughe & J. Mighty (Eds.), *Taking Stock: Research on Teaching and Learning in Higher Education* (pp. 3-13). Montreal and Kingston: McGill-Queen’s University Press.

Cierniak, G., Scheiter, K., & Gerjets, P. (2009). Explaining the split-attention effect: Is the reduction of extraneous cognitive load accompanied by an increase in germane cognitive load? *Computers in Human Behaviour, 25*(2), 315-324. doi:10.1016/j.chb.2008.12.020.

Clark, R. C., & Mayer, R. E. (2008). Learning by viewing versus learning by doing: Evidence-based guidelines for principled learning environments. *Performance Improvement, 47*(9), 5-13.

Clark, R., Nguyen, F., & Sweller, J. (2006). *Efficiency in Learning: Evidence-based Guidelines to Manage Cognitive Load.* San Francisco: Pfeiffer.

Classroom clipart. (2009). http://classroomclipart.com/clipart-view/Maps/Black_and_ White _World_Maps/Zimbabwe_map_31Mbw_jpg.htm. Retrieved 5 April 2015.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences* (2nd ed.). New Jersey: Lawrence Erlbaum Associates.

Conway, A. R. A., Jarrold, C., Kane, M. J., Miyake, A., & Towse, J. (2007). Variation in working memory: An introduction. In A. R. A. Conway, C. Jarrold, M. J. Kane, A., Miyake, & J. Towse (Eds.), *Variation in Working Memory*. Oxford University Press.

Cooper, G. (1990). Cognitive load theory as an aid for instructional design. *Australasian Journal of Educational Technology*, *6*(2), 108-113.

Cooper, G. (1998). Research into cognitive load theory and instructional design at UNSW. Retrieved from http://education.arts.unsw.edu.au/CLT_NET_Aug_97 .HTML.

Cooper, E., & Pantle, A. (1967) The total-time hypothesis in verbal learning, *Psychological Bulletin 68*(October 1967), 221-234.

Cooper, G., & Sweller, J. (1987). Effects of schema acquisition and rule automation on mathematical problem-solving transfer. *Journal of Educational Psychology*, *79*(4), 347-362.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, *24*, 87–114. doi:10.1017/S0140525X01003922.

Cowan, N. (2005). *Working Memory Capacity*. New York, NY : Psychology Press.

Cowan, N. (2008). What are the differences between long-term, short-term, and working memory? *Progress in Brain Research, 169,* 323–338.doi:10.1016/ S0079-6123(07)00020-9.

Cowan, N. (2014). Working Memory Underpins Cognitive Development, Learning, and Education. *Educational Psychology Review*, *26*(2), 197-223.doi:10.1007/s10 648-013-9246-y.

Cowan, N., Nugent, L. D., Elliot, E. M., Ponomarev, I., & Saults, J. S. (1999). The role of attention in the development of short-term memory: Age differences in the verbal span of apprehension. *Child Development 70*, 1082–1097. doi:10.1111/1467-8624.00080.

David, F. R., David, M. E., & David, F. R. (2011). What are business schools doing for Business today? Business Horizons, 54(1), 51-62. Retrieved from www.CheckmatePlan.com.

De Groot, A. D. (1965). *Thought and Choice in Chess*. The Hague: Mouton

De Lange, P., Jackling, B., & Gut, A. (2006). Accounting graduates perceptions of skills emphasis in undergraduate courses: an investigation from two Victorian universities. *Accounting and Finance*, *46*(3), 365-386.doi:1 0.1111 /j.1467629X. 2006.00173.x.

Dearing, R. (1997). Higher education in the learning society [Dearing report].

De Leeuw, K. E., & Mayer, R. E. (2008). A comparison of three measures of cognitive load: Evidence for separable measures of intrinsic, extraneous, and germane load. *Journal of Educational Psychology, 100*(1), 223.doi:10. 1037/00220663. 100.1.223.

De Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional Science, 38*(2), 105–134.

Diao, Y., Chandler, P., & Sweller, J., (2007). The effect of written text on comprehension of spoken English as a foreign language. *The American Journal of Psychology*, *120*(2), 237- 261.

Duchac, J. E., & Amoruso, A. J. (2011). A descriptive study of institutional characteristics of the introductory accounting course. *Issues in Accounting Education, 27*(1), 1-16.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review*, *102*(2), 211.doi:10.1037/0033-295X.102.2.211.

Errey, C., Ginns, P., & Pitts, C. (2006). Cognitive load theory and user interface design: making software easy to use. (Part 1). *PTG Global*. http://www.ptg-global.com/PDFArticles. Retrieved on March, 14, 2014.

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of Engineering Education*, *94*(1), 57-72.doi:10.1002/j.2168-9830 .2005.tb00829.x.

Florax, M., & Ploetzner, R. (2010). What contributes to the split-attention effect? The role of text segmentation, picture labelling, and spatial proximity. *Learning and Instruction, 20*(3), 216-224.doi:10.1016/j.learninstruc.2009.02.021.

Fogarty, T. J. (2010). Revitalizing accounting education: A highly applied liberal arts approach. *Accounting Education: An International Journal, 19*(4), 403-419.

Friedenberg, J., & Gordon S. (2010). *Cognitive Science: An Introduction of the Study of Mind*. United States of America: SAGE Publications.

Gabbin, A. L. (2002). The crisis in accounting education. *Journal of Accounting Education, 193* (4), 81-86.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational research: An Introduction* (7th ed.). New York: Allyn and Bacon.

Galy, E., Cariou, M., & Mélan, C. (2012). What is the relationship between mental workload factors and cognitive load types? *International Journal of Psychophysiology, 83*(3), 269-275.doi:10.1016/j.ijpsycho.2011.0 9.023.

Gathercole, S. E., & Alloway, T. P. (2008). *Working Memory and Learning: A Practical Guide*. Sage Press.

Geary, D. (2007). Educating the evolved mind: Conceptual foundations for an evolutionary educational psychology. In J. S. Carlson & J. R. Levin (Eds.), *Psychological Perspectives on Contemporary Educational Issues* (pp. 1 – 99). Greenwich, CT: Information Age.

Geary, D. (2008). An evolutionarily informed education science. *Educational Psychologist , 43*, 179 – 195.doi:10.1080/00461520802392133.

Gilchrist, A.L., Cowan, N., & Naveh-Benjamin, M. (2008). Working memory capacity for spoken sentences decreases with adult aging: Recall of fewer, but not smaller chunks in older adults. *Memory*. *16*, 773–787.doi:10.108 0/09658210 802261124.

Gimino, A. (2000). *Factors that Influence Student's Investment of Mental Effort in Academic Tasks: A Validation and Exploratory Study*. Unpublished dissertation, Rossier School of Education, University of Southern California.

Ginns, P. (2005). Meta-analysis of the modality effect. *Learning and Instruction, 15* (4), 313 – 331.doi:10.1016/j.learninstruc.2005.07.001.

Ginns, P. (2006). Integrating information: a meta-analysis of the spatial contiguity and temporal contiguity effects. *Learning and Instruction*, *16*(6), 511–525. doi:10.1016/j.learninstruc.2006.10.001.

Goldstein, K. M., & Blackman, S. (1978). *Cognitive style: Five approaches and Relevant Research*. John Wiley & Sons.

Goolkasian, P., Foos, P. W., & Eaton, M. (2009). Modality effects in sentence recall. *The Journal of general psychology, 136*(2), 205-224.doi:10.3200/ GENP.136.2.205-224.

Gopher, D., & Braune, R. (1984). On the psychophysics of workload: Why bother with subjective measures? *Human Factors, 26*, 519–532.

Gutchess, A. H., Schwartz, A. J., & Boduroğlu, A. (2011). The influence of culture on memory. In D. D. Schmorrow & C. M. Fidopiastis (Eds.), *Foundations of Augmented Cognition: Directing the Future of Adaptive Systems*, (pp. 67–76). Berlin/Heidelberg, Germany: Springer.

Halabi, A. K., Tuovinen, J.E., & Farley, A.A. (2005). Empirical evidence on the relative efficiency of worked examples versus problem-solving exercises in accounting principles instruction. *Issues in Accounting Education, 20*(1), 21-32. doi:10.2308/iace.2005.20.1.21.

Halabi, A. (2006). Applying an instructional efficiency model to determine the most efficient feedback for teaching introductory accounting. *Global Perspectives on Accounting Education 3*(3), 93–113.

Halpern, D. F. (2003). *Thought and knowledge: An Introduction to Critical Thinking* (4th ed.). Mahwah, NJ: Erlbaum.

Harrison, W. T., Horngren, C. T., & Thomas, B. (2010). *Financial Accounting* (8th ed.). Upper Saddle River, NJ: Prentice-Hall.

Harskamp, E. G., Mayer, R. E., & Suhre, C. (2007). Does the modality principle for multimedia learning apply to science classrooms? *Learning and Instruction, 17*(5), 465–477.doi:10.1016/j.learninstruc.2007.09.010.

Harvey,O. J., Hunt, D.E., & Schroder, H.M. (1961). *Conceptual Systems and Personality Organisation*. New York: Wiley.

Hasler, B. S., Kersten, B., & Sweller, J. (2007). Learner control, cognitive load and instructional animation. *Applied Cognitive Psychology*, 21(6), 713-729. doi:10.1002/acp.1345.

Heikkila, A., & Lonka, K. (2006). Studying in higher education: students’ approaches to learning, self-regulation, and cognitive strategies. *Studies in Higher Education, 31*(1), 99-117. doi:10.1080/03075070500392433.

Henderson, S. (2001). The education of accountants—A comment. *Accounting Forum, 25*(4) 398–401.

Henson, K. T., & Eller, B. E (1999). *Educational Psychology for Effective Teaching*. Albany, NY: Wadsworth.

Hoggett, J., Edwards, L., Medlin, J., & Tilling, M. (2012). *Accounting*. Australia: John Wiley & Sons.

Hoppe, P. (2000, November 25). *Welcome to the* "*Perilous*" *Discussion Forum*. Message posted to http://aaahq.org:8888/webx?50@4.EvZWabeGaHi'O@.eec29a4. Retrieved on 14 March 2014.

ICAA (Institute of Chartered Accountants in Australia). (2001). *The New CFO of the Future: Finance Functions in the Twenty-first Century*. Prepared by M. Simister for KPMG consulting for the ICAA (ICAA, Sydney, NSW).

Ingram, R., & Howard, T. (1998). The association between course objectives and grading methods in introductory accounting courses. *Issues in Accounting Education, 13*, 815–832.

Jelsma, O., Van Merriënboer, J. J. G., & Bijlstra, J. P. (1990). The ADAPT design model: Towards instructional control of transfer. *Instructional Science, 19*, 89–120.

Johnson, S., Schmidt, B., Teeter, S., & Henage, J. (2008). Using the Albrecht and Sack study to guide curriculum decisions. *Advances in Accounting Education, 9*, 251-266.doi:10.1016/S1085-4622(08)09012-3.

Jones, S., Fong, C., Torres, L., Yoo, J., Decker, M., & Robinson, D. H. (2010). Productivity in educational psychology journals from 2003–2008. *Contemporary Educational Psychology, 35*, 11–16.

Just, M. A., Carpenter, P. A., Keller, T. A., Emery, L., Zajac, H., & Thulborn, T. R. (2001). Interdependence of non-overlapping cortical systems in dual cognitive tasks. *Neuroimage, 14*, 417–426. doi:10.1006/nimg.2001.0826.

Kalyuga, S. (2006). Assessment of learners' organised knowledge structures in adaptive learning environments. *Applied Cognitive Psychology, 20*(3), 333-342. doi:10.1002/acp.1249.

Kalyuga, S. (2007). Expertise reversal effect and its implications for learner-tailored instruction. *Educational Psychology Review, 19*(4), 509-539. doi:10.1007/s10648-007-9054-3.

Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*(1), 23–31.doi:10.1207/S15326985EP3801_ 4.

Kalyuga, S. P., Chandler, P., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. *Applied Cognitive Pschology*, *13*(4) 351-371.doi:10.1002/(SICI)1099-0720(199908)13:4<351::AID-ACP589>3.0.CO;2-6.

Kalyuga, S., Chandler, P., & Sweller, J. (2000). Incorporating learner experience into the design of multimedia instruction. *Journal of Educational Psychology, 92,* 126-136.doi:10.1037/0022-0663.92.1.126.

Kalyuga, S. P., Chandler, P., & Sweller, J. (2001). Learner experience and efficiency of instructional guidance. *Educational Psychology, 21*(1), 5-23. doi: 10.1080/01443410124681.

Kalyuga, S. P., Chandler, P., Tuovinen, J., & Sweller, J. (2001). When problem solving is superior to studying worked examples. *Journal of Educational Psychology, 93*, 579-588. doi:10.1037/0022-0663.93.3.579.

Kalyuga, S., & Renkl, A. (2010). Expertise reversal effect and its instructional implications: Introduction to the special issue. *Instructional Science, 38*, 209–215. doi:10.1007/s11251-009-9102-0.

Kalyuga, S., Renkl, A., & Paas, F. (2010). Facilitating flexible problem solving: A cognitive load perspective. *Educational Psychology Review, 22*(2), 175-186. doi:10.1007/s10648-010-9132-9.

Kalyuga, S., Rikers, R., Paas, F. (2012). Educational Implications of Expertise Reversal Effects in Learning and Performance of Complex Cognitive and Sensorimotor Skills. *Educational Psychology Review*, *24*(2), 313 – 337. doi:10.1007/s10648-012-9195-x.

Kester, L., Kirschner, P. A., & Merriënboer, J. J. (2005). The management of cognitive load during complex cognitive skill acquisition by means of computer-simulated problem solving. *British Journal of Educational Psychology, 75*(1), 71-85. doi:10.1348/000709904X19254.

Kester, L., Kirschner, P. A., & Van Merriënboer, J. J. (2006). Just-in-time information presentation: Improving learning a troubleshooting skill. *Contemporary Educational Psychology, 31*(2), 167-185. doi: 10.1016/j.cedpsych. 2005.04.002.

King, G.H., & McConnell, C. (2010). Using a common experience to teach introductory managerial accounting. *Journal of Instructional Pedagogies, 4*, 1-8.

Kirk, R. E. (1982). *Experimental Design* (2nd ed). Monterey, California: Brooks/Cole.

Kirk, R. E. (1995). *Experimental Design*. Pacific Grove, CA: Brooks. Cole Publishing Co.

Kirschner, P. A. (2002). Cognitive load theory: Implications of cognitive load theory on the design of learning. *Learning and Instruction, 12*(1), 1–10. doi:10.1016/S0959-4752(01)00014-7.

Kirschner, P. A., Ayres, P., & Chandler, P. (2011). Contemporary cognitive load theory research: The good, the bad and the ugly. *Computers in Human Behavior, 27*(1), 99-105. doi:10.1016/j.chb.2010.06.025.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75–86.doi:10.1207/s15326985ep41 02_1.

Kissane, M., Kalyuga, S., Chandler, P., &Sweller, J. (2008).The consequences of fading instructional guidance on delayed performance: The case of financial services training’, *Educational Psychology: an International Journal of Experimental Educational Psychology*, *28* (7), 809–822. doi:10.1080/01443410802322069.

Kok, E. M., de Bruin, A. B. H., Robben, S. G. F., & Van Merriënboer, J. J. G. (2012). Looking in the same manner but seeing it differently: Bottom-up and expertise effects in radiology. *Applied Cognitive Psychology*, *26*(6), 854–862.doi: 10.1002 /acp.2886.

Lazic, S. E. (2008). Why we should use simpler models if the data allow this: relevance for ANOVA designs in experimental biology. *BMC physiology, 8*(1), 16. doi:10.1186/1472-6793-8-16.

Leahy, W., Chandler, P., & Sweller, J. (2003). When auditory presentations should and should not be a component of multimedia instruction. *Applied Cognitive Psychology, 17*(4), 401-418.doi:10.1002/acp.877.

Leslie, K.C., Low, R., Jin, P., & Sweller, J. (2012). Redundancy and expertise reversal effects when using educational technology to learn primary school science. *Educational Technology Research and Development*, *60*(1),1-13.doi:10.1007/ s11423-011-9199-0.

Leveson, L. (2004). Encouraging better learning through better teaching: a study of approaches to teaching in accounting. *Accounting Education. An International Journal, 13*(4), 1-20.doi:10.1080/0963928042000306819.

Liu, T. C., Lin, Y. C., Tsai, M. J., & Paas, F. (2012). Split-attention and redundancy effects on mobile learning in physical environments. *Computers & Education, 58*(1), 172-180.doi:10.1016/j.compedu.2011.08.007.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American psychologist*, *57*(9), 705-717. doi:10.1037/0003-066X.57.9.705.

Lovett, M., & Greenhouse, J.B. (2000). Applying cognitive theory to statistics instruction. *The American Statistician, 54*(3), 196-206.doi:10.2 307 /2685 590.

Lloyd, C. B., & Abbey, A. (2009). Teaching elementary accounting to non-accounting majors. *Journal of Business Education, 2*(2), 23-30.

Lucas, U. (2001). Deep and surface approaches to learning within introductory accounting: A phenomenographic study. *Accounting Education, 10*(2), 161-184. doi:10.1080/09639280110073443.

Lucas, U., & Mladenovic, R. (2006). Developing new world views: threshold concepts in introductory accounting, in: J. H. F. Meyer & R. Land (Eds.), *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge* (pp.148–159). London: Routledge Falmer.

Lucas, U., & Mladenovic, R. (2007). The potential of threshold concepts: An emerging framework for educational research and practice. *London Review of Education, 5*(3), 237-248. doi:10.1080/14748460701661294.

Moncada, S. M., & Sanders, J. C. (1999). Perceptions in the recruiting process. *The CPA Journal*. Retrieved from http://www.nysscpa.org/cpajournal/1999.

Marcus, N., Cooper, M., & Sweller, J. (1996). Understanding instructions. *Journal of Educational Psychology, 88*(1), 49-63. doi:10.1037/0022-0663.88.1.49.

Mayer, R. E. (2001). *Multimedia Learning*. New York: Cambridge University Press doi:10.1017/CBO9781139164603.

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory into Practice, 41*(4), 226-232. doi:10.1207/s15430421tip4104_4.

Mayer, R. E. (2005). Principles for managing essential processing in multimedia learning: segmenting, pre-training, and modality. In R.E. Mayer (Ed.), *Cambridge Handbook of Multimedia Learning* (pp.169–182). New York: Cambridge University Press.

Mayer, R. E. (2010). *Applying the Science of Learning*.Upper Saddle River,NJ: Pearson.

Mayer, R. E., & Chandler, P. (2001). When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology, 93*(2), 390–397. doi:10.1037/0022-0663. 93.2.390

Mayer, R. E., & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction, 12*(1), 107-119. doi:10.1016/S0959-4752(01)00018-4

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 43-52.doi:10.1207/S15326985EP3801_6.

Mayer, R. E., & Wittrock, M. C. (1996). Problem-solving transfer. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 47–62). New York: Macmillan.

Mautone, P. D., & Mayer, R. E. (2001). Signaling as a cognitive guide in multimedia learning. *Journal of Educational Psychology, 93*(2), 377-389.doi:10.1037/0022-0663.93.2.377.

Mautone, P. D., & Mayer, R. E. (2007). Cognitive aids for guiding graph comprehension. *Journal of Educational Psychology, 99*(3), 640-652.doi:10. 1037/0022-0663.99.3.640.

McHugh, M. L. (2011). Multiple comparison analysis testing in ANOVA. *Biochemia medica, 21*(3), 203-209. doi:10.11613/BM.2011.029.

Mertens, D. M. (2005). *Research and Evaluation in Education and Psychology : Integrating Diversity with Quantitative, Qualitative, and Mixed Methods* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Miglietti, C. (2002). Using cooperative small groups in introductory accounting classes: A practical approach. *Journal of Education for Business, 78* (November/December), 111–115. doi:10.1080/0883 2320209599 707.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63*(2), 81–97 doi:10.1037/h0043158.

Moreno, R. (2006). When worked examples don't work: Is cognitive load theory at an impasse? *Learning and Instruction, 16*(2), 170-181.doi:10.1016/j.learninstruc. 2006.02.006.

Moreno, R. (2010). *Educational Psychology*. Wiley.

Moreno, R., & Mayer, R. (2002). Verbal redundancy in multimedia learning: When reading helps listening. *Journal of Educational Psychology, 94*(1), 156–163. doi:10.1037/0022-0663.94.1.156.

Morris, P. E., Tweedy, M. and Gruneberg, M.M. (1985). Interest, knowledge, and the memorization of soccer scores. *British Journal of Psychology, 76*(4), 415-425 doi:10.1111/j.2044-8295.1985.tb01965.x.

Morrison, B. B., Dorn, B., & Guzdial, M. (2014). Measuring cognitive load in introductory CS: adaptation of an instrument. In *Proceedings of the Tenth Annual Conference on International Computing Education Research* (pp. 131-138). ACM.doi:10.1145/2632320.2632348.

Mostyn, G. R. (2012). Cognitive load theory: What it is, Why its important for accounting instruction and research. *Issues in Accounting Education*, *27*(1), 227-245. doi:10.2308/iace-50099.

Mousavi, S. Y., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology*, *87*(2), 319.doi:10.1037/0022-0663.87.2.319.

Nisbett, R. E., & Masuda, T. (2003). Culture and point of view. *Proceedings of the National Academy of Sciences*, *100*(19), 11163-11170.

Norusis, M. (2008). *SPSS Statistics 17.0. Guide to Data Analysis*. New Jersey: Prentice Hall.

O'Donnel, R., & Eggemeier, F. T. (1986). Workload assessment methodology. In K. Boff, L. Kaufman & J. Thomas (Eds.), *Handbook of Perception and Human Performance* (pp. 42.1–42.49). New York: Wiley.

Oksa, A., Kalyuga, S., & Chandler, P. (2010). Expertise reversal effect in using explanatory notes for readers of Shakespearean text. *Instructional Science*, *38*(3), 217-236.doi:10.1007/s11251-009-9109-6.

Ormrod, J. E. (1998). *Educational Psychology: Developing Learners*. Columbus, OH: Prentice Hall.

Owens, P., & Sweller, J. (2008). Cognitive load theory and music instruction. *Educational Psychology*, *28*(1), 29-45. doi:10.1080/014434107013 69146.

Ozcinar, Z. (2009). The topic of instructional design in research journals: A citation analysis for the years 1980-2008. *Australasian Journal of Educational Technology*, *25*(4), 559-580.

Paas, F. (1992). Training strategies for attaining transfer of problem-solving skill in statistics: A cognitive-load approach. *Journal of Educational Psychology, 84*(4), 429-434. doi:10.1037/0022-0663.84.4.429.

Paas, F., & Ayres, P. (2014). Cognitive load theory: A broader view on the role of memory in learning and education. *Educational Psychology Review, 26*(2), 191-195.doi:10.1007/s10648-014-9263-5.

Paas, F., Renkel, A., & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 32*(1), 1-8. doi:10.1023/B: TRUC.00000218 06.17516.d0.

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist, 38*(1), 1-4. doi:10.1207/S15326985EP3801_1.

Paas, F., Tuovinen, J., Tabbers, H., & Van Gerven, P.W.M. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist, 38*(1), 63-71. doi:10.1207/S15326985EP3801_8.

Paas, F., & Van Gog, T. (2006). Optimising worked example instruction: Different ways to increase germane cognitive load. *Learning and Instruction*, *16*(2), 87–91. doi:10.1016/j.learninstruc.2006.02.004.

Paas, F., Van Gog, T., & Sweller, J. (2010). Cognitive load theory: New conceptualizations, specifications, and integrated research perspectives. *Educational Psychology Review, 22*(2), 115–121.doi:10.1007/s10648-010-9133 8.

Paas, F., Van Merriënboer, J. J. G. (1993). The efficiency of instructional conditions: An approach to combine mental effort and performance measures. *Human Factors, 35*(4), 737-743.

Paas, F. G., & Van Merriënboer, J. J. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review, 6*(4), 351-371.doi:10.1007/BF02213420.

Patricia L. H., Chen, C. H., Huang, S, H., Chiang, C.T., Jen, F. L., & Warden, L (2006). Factors Influencing High School Students' Academic Motivation in Taiwan, *Asia-Pacific Journal of Education*, *26*(2), 189- 207.doi:10.1080/02188790600937326.

Phillips, F. & Heiser, L. (2011). A field experiment examining the effects of accounting equation emphasis and transaction scope on students learning to journalize. *Issues in Accounting Education*, *26*(4), 681-699. doi:10.2308/iace-50051.

Plass, J. L., Moreno, R., & Brünken, R. (2006). *Cognitive Load Theory*. Cambridge, GBR: Cambridge University Press.

Pollock, E. Chandler, P., & Sweller, J. (2002). Assimilating complex information. *Learning and Instruction, 12*(1), 61-86. doi:10.1016/S0959-4752(01)00016-0.

Pociask, F. D., & Morrison, G. R. (2008). Controlling split attention and redundancy in physical therapy instruction. *Educational Technology Research and Development, 56*(4), 379-399. doi:10.1007/s11423-007-9062-5.

Raaijmakers, J. G. W., & Shiffrin, R. M. (2003). Models versus descriptions: Real differences and language differences. *Behavioral and Brain Sciences, 26*(6), 753-753.doi:10.1017/S0140525X0349016X.

Reed, W. M., Burton, J. K., & Kelly, P. (1985). The effects of writing ability and mode of discourse on cognitive capacity engagement. *Research in the Teaching of English, 19*(3), 283–297.

Renkl, A. (2005). The worked-out examples priniciple in multimedia learning. In R.E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp. *229-245).* Cambridge: Cambridge University Press. doi:10.1017/CBO9780511816819.016.

Roberts, F. D., Kelley, C. L., & Medlin, B. D. (2007). Factors influencing accounting faculty members' decision to adopt technology in the classroom. *College Student Journal*, *41*(2), 423-435.

Roodenrys, K., Agostinho, S., Roodenrys, S., & Chandler, P. (2012). Managing one's own cognitive load when evidence of split-attention is present. *Applied Cognitive Psychology, 26*(6), 878-886. doi:10.1002/acp.2889.

Rose, J. M., & Wolfe, C. J. (2000). The effects of system design alternatives on the acquisition of tax knowledge from a computerized tax decision aid. *Accounting, Organizations and Society, 25*(3), 285–306. doi:10.1016/S0361-3682(99) 00048-3.

Rudner, M., & Rönnberg, J. (2008). The role of the episodic buffer in working memory for language processing. *Cognitive Processing, 9*(1), 19–28. doi:10.1007/s 10339-007-0183-x.

Russell, R. (2012). *Cognition: Theory and practice*. New York, NY: Worth Publishers. doi:10.1007/s10071-011-0426-1.

Saariluoma, P. (1995). *Chess Players' Thinking.* London: Routledge.

Samur, Y. (2012). Redundancy effect on retention of vocabulary words using multimedia presentation. *British Journal of Educational Technology*, *43*(6), (E166–E170).doi:10.1111/j.1467-8535.2012.01320.x.

Sangster, A. (2010). Using accounting history and Luca Pacioli to put relevance back into the teaching of double entry. *Accounting, Business & Financial History, 20*(1), 23-39. doi:10.1080/09585200903504215.

Sangster, A., Franklin, E., Alwis, D., Abdul-Rahim, J., & Stoner, G. (2014). Main article: Using Pacioli's pedagogy and medieval text in today's introductory accounting course. *Journal Of Accounting Education, 32*(2014), 16-35. doi:10.1016/j.jaccedu.2013.12.001.

Saunders, G., & Christopher, J. E. R. (2003). Teaching outside the box: a look at the use of some non-traditional teaching models in accounting principles courses. *Journal of American Academy of Business, 3*(1–2), 162–165.

Saudagaran, S. M. (1996). The first course in accounting: An innovative approach. *Issues in Accounting Education, 11*(1), 83–94.

Schacter, D. L. (2001). The seven sins of memory: How the mind forgets and remembers. Boston: Houghton Mifflin. (translations: Chinese, Czech, Finnish, French, German, Hebrew, Hungarian, Italian, Japanese, Korean, Polish, Portuguese, Spanish) Schoenfeld, A. H. (Ed.) (1987), *Cognitive Science and Mathematics Education*. Hillsdale, NJ: Erlbaum.

Schmeck, A., Opfermann, M., Van Gog, T., Paas, F., & Leutner, D. (2015). Measuring cognitive load with subjective rating scales during problem solving: differences between immediate and delayed ratings. *Instructional Science*, *43*(1), 93-114. doi:10.1007/s11251-014-9328-3.

Schoenfeld, A. H. (1987). What's all the fuss about metacognition? In A. H. Schoenfeld (Ed.), *Cognitive Science and Mathematics Education* (pp. 189-215). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schunk, D. H., & Zimmerman, B. J. (2006). Competence and control beliefs: Distinguishing the means and the ends. In P. Alexander & P. Winne (Eds.), *Handbook of Educational Psychology* (2nd ed., pp. 349–367). San Diego, CA: Academic Press.

Scofield, B. W., & Dye, W. (2009). Introducing the accounting equation with M&M's. *American Journal of Business Education*, *2*(7), 127-137.

Smith, E. E., & Jonides, J. (1997). Working memory: A view from neuroimaging. *Cognitive Psychology, 33*, 5–42. doi:10.1006/cogp.1997.0658.

South African Institute of Chartered Accountants (SAICA). (2008). *Competencies of a Chartered Accountant (SA) at Entry Point to the Profession*. Available at <https://www.saica.co.za/Portals/0/documents/CompetencyFramework_CAs_Summary.pdf>, Retrieved on 24 October 2014).

Spiceland, J. D., Thomas, W. M., & Herrmann, D. (2009). *Financial Accounting* (1st ed). Burr Ridge, IL: McGraw-Hill/Irwin.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257-285. doi:10.1207/s15516709cog120 2_4.

Sweller, J. (1993). Some cognitive processes and their consequences for the organisation and presentation of information. *Australian Journal of Psychology, 45*(1), 1-8. doi:10.1080/00049539308259112.

Sweller, J. (1994). Cognitive load theory, learning difficulty and instructional design. *Learning and Instruction, 4*(4), 295-312. doi:10.1016/09594752(94) 90003-5.

Sweller, J. (1999). Instructional design in technical areas. *Australian Science Teachers Journal, 45*(4), 59-60.

Sweller, J. (2003). Evolution of human cognitive architecture. In B. Ross (ed.), *The Psychology of Learning and Motivation* (pp. 215 - 266). San Diego: Academic Press. doi:10.1016/S0079-7421(03)01015-6.

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32*(1-2), 9–31. doi:10.1023/B:TRUC.0000021808.72598.4d.

Sweller, J. (2006). The worked example effect and human cognition. *Learning and Instruction, 16*(2), 165–169. doi:10.1016/j.learninstruc.2006.02.005.

Sweller, J. (2008). Instructional implications of David C. Geary's evolutionary educational psychology. *Educational Psychologist, 43*(4), 214-216. doi:10.1080/00461520802392208.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review, 22*(2), 123–138.doi:10.1007/ s10648-010-9128-5.

Sweller, J. (2012). Human cognitive architecture: Why some instructional procedures work and others do not. In K. R. Harris., S. Graham, & T. Urdan (Eds.), *APA Educational Psychology Handbook* (pp.295–325). Washington: American Psychological Association. doi:10.1037/13273-011.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. New York: Springer. doi:10.1007/978-1-4419-8126-4.

Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. *Cognition and Instruction, 12*(3), 185-233. doi:10.1207/s1532690xci1203_1.

Sweller, J., & Cooper, G.A. (1985). The use of worked examples as a substitute for problem solving in learning algebra. *Cognition and Instruction, 2*(1), 59-89. doi:10.1207/s1532690xci0201_3.

Sweller, J., Van Merriënboer, J. J.G., & Paas, F. G. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-296.doi:10.102 3/A:1022193728205.

Tarmizi, R., & Sweller, J. (1988). Guidance during mathematical problem solving. *Journal of Educational Psychology, 80* (4), 424-436. doi:10.1037/002 2-0663.80.4.424.

Tindall-Ford, S., Agostinho, S., Bokosmaty, S., Paas, F., & Chandler, P. (2015). Computer-based learning of mathematical concepts by studying instructor-managed or self- managed split-attention materials. *Education Technology and Society (Online).*

Tindall-Ford, S., Chandler, P., & Sweller, J. (1997). When two sensory modes are better than one. *Journal of Experimental Psychology: Applied, 3*(4), 257. doi:10.1037/1076-898x.3.4.257.

Van Bruggen, J. M., Kirschner, P. A., & Jochems, W. (2002). External representation of argumentation in CSCL and the management of cognitive load. *Learning and Instruction, 12*(1), 121-138. doi:10.1016/S0959-4752(01)00019-6.

Van Gerven, & Pascal W. M. (2003). The efficiency of multimedia learning into old age. *British Journal of Educational Psychology, 73*(4), 489-505. doi:10.1348/00 0709903322591208.

Van Gog, T., Kirschner, F., Kester, L., & Paas, F. (2012). Timing and frequency of mental effort measurement: Evidence in favour of repeated measures. *Applied Cognitive Psychology, 26*(6), 833-839. doi:10.1002/acp.2883.

Van Gog, T., & Paas, F. (2008). Instructional efficiency: Revisiting the original construct in educational research. *Educational Psychologist, 43*(1), 16-26. doi:10.1080/00461520701756248.

Van Loon-Hillen, N., Van Gog, T., & Brand-Gruwel, S. (2012). Effects of worked examples in a primary school mathematics curriculum. *Interactive Learning Environments, 20*(1), 89-99. doi:10.1080/10494821003755510.

Van Merriënboer, J. J. G., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *Educational Technology Research and Development, 53*(3), 5-13. doi:10.1007/BF02504793.

Van Merriënboer, J. J. G., & Paas, F. G. W. C. (1990). Automation and schema acquisition in learning elementary computer programming: Implications for the design of practice. *Computers in Human Behaviour*, *6*(3), 273–289. doi:10.1016/0747-5632(90)90023-A.

Van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review, 17*(2), 147-177. doi:10.1007/s10648-005-3951-0.

Ward, M., & Sweller, J. (1990). Structuring effective worked examples. *Cognition and Instruction, 7*(1), 1-39. doi:10.1207/s1532690xci0701_1.

Weiten, W. (2013). *Psychology: Themes and Variations* (9th ed.) Wadsworth, Cengage Learning.

Weygandt, J. J., Chalmers, K., Mitrione, L., Fyfe, M., Kieso, D. E., & Kimmel, P. D. (2010). *Principles of Financial Accounting* (2nd ed.). Australia: John Wiley & Sons Australia Ltd.

Willingham, D.B., Nissen, M.J., & Bullemer, P. T. (1989). On the development of procedural knowledge. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(6) ,1047-1060. doi:10.1037/02787393. 15.6.1047.

Wood, L.I. (2012). The coach-team approach: an introductory accounting instructional alternative. *Journal of Instructional Pedagogies, 8,* 1-9.

Wouters, P., Paas, F., & Van Merriënboer, J. J. G. (2008). How to optimize learning from animated models: A review of guidelines based on cognitive load. *Review of Educational Research, 78*(3), 645–675. doi:10.3102/00346543 08320320.

Yeung, A., Jin, P., & Sweller, J. (1998). Cognitive load and learner expertise: Split-attention and redundancy effects in reading with explanatory notes. *Contemporary Educational Psychology, 23*(1), 1–21.doi:10.1006/ceps.1997.0951.

Yvonne, B., & Kola, S. (2001). An analysis of high school students' performance on five integrated science process skills. *Research in Science & Technological Education, 19*(2), 133-145. doi:10.1080/02635 140120087687.

Zeidner, M., Boekaerts, M., & Pintrich, P. R. (2000). Self-regulation: Directions and challenges for future research. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-regulation* (pp. 750-769). San Diego, CA: Academic Press. doi: 10.1016/B978-012109890-2/50052-4.

Appendix A: Degree Programs of Students who Participated in the Research

Students who participated in the research were enrolled in the following degree programs at Great Zimbabwe University:

1	Bachelor of Commerce Honours Degree in Accounting
2	Bachelor of Commerce Honours Degree in Information Systems
3	Bachelor of Commerce Honours Degree in Internal Auditing
4	Bachelor of Commerce Honours Degree in Banking and Finance
5	Bachelor of Commerce Honours Degree in Finance
6	Bachelor of Commerce Honours Degree in Risk Management and Insurance
7	Bachelor of Commerce Honours Degree Programme in Financial Engineering
8	Bachelor of Commerce Honours Degree in Marketing
9	Bachelor of Commerce Honours Degree in Business Management
10	Bachelor of Commerce Honours Degree in Office Management
11	Bachelor of Commerce Honours Degree in Logistics and Transport Management
12	Bachelor of Commerce Honours Degree in Economics
13	Bachelor of Commerce Honours Degree in Economics And Finance

Appendix B: Paas (1992) Cognitive Load Rating Scale

In solving or studying the preceding problem I invested

1. very, very low mental effort
2. very low mental effort
3. low mental effort
4. rather low mental effort
5. neither low nor high mental effort
6. rather high mental effort
7. high mental effort
8. very high mental effort
9. very, very high mental effort

Paas, (1992); Paas et al. (2003).

Appendix C: UOW Approval of Research Project Letter

UNIVERSITY OF WOLLONGONG

In reply please quote: HE14/014
6 February 2014

Mr Seedwell Tanaka Muyako Sithole
2/15 Mercury Street, WOLLONGONG NSW 2500

Dear Mr Sithole

Thank you for your response dated 31 January 2014 to the HREC review of the application detailed below. I am pleased to advise that the application has been approved.

Ethics Number: HE14/014

Project Title:	Self-management of cognitive load in accounting. A case example of university students
Researchers:	Mr Seedwell Tanaka Muyako Sithole, Professor Paul Chandler A/Professor Indra Abeysekera,
Approval Date:	6 February 2014
Expiry Date:	5 February 2015

The University of Wollongong/Illawarra Shoalhaven Local Health District Social Sciences HREC is constituted and functions in accordance with the NHMRC *National Statement on Ethical Conduct in Human Research.* The HREC has reviewed the research proposal for compliance with the *National Statement* and approval of this project is conditional upon your continuing compliance with this document.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at http://www.uow.edu.au/research/rso/ethics/UOW009385.html. This report must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

As evidence of continuing compliance, the Human Research Ethics Committee also requires that researchers immediately report:

• proposed changes to the protocol including changes to investigators involved
• serious or unexpected adverse effects on participants
• unforseen events that might affect continued ethical acceptability of the project.

Please note that approvals are granted for a twelve month period. Further extension will be considered on receipt of a progress report prior to expiry date.

If you have any queries regarding the HREC review process, please contact the Ethics Unit on phone 4221 3386 or email rso-ethics@uow.edu.au.

Yours sincerely

Professor Kathleen Clapham
Chair, Social Sciences
Human Research Ethics Committee

Ethics Unit, Research Services Office
University of Wollongong NSW 2522
Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web:www.uow.edu.au

Appendix D: Participant Information Sheet

UNIVERSITY OF WOLLONGONG

PARTICIPANT INFORMATION SHEET

Self-Management of Cognitive Load in Accounting Within a Zimbabwean University Context.

Dear participant

Purpose of the Research

Thank you for accepting to participate in this study which is being conducted by Seedwell Tanaka Muyako Sithole for his Doctor of Philosophy degree supervised by A/Professor Indra Abeysekera and Professor Paul Chandler in the Department of Accounting and Finance at the University of Wollongong. The study is investigating aspects of cognitive load theory (CLT). CLT is a theory of learning that developed out of direct examination of human cognitive architecture. It assists us to understand how humans learn and ways to improve our limited working memory capacities.

Method and Demands for Participants

You will be asked to complete the following tasks in order to ascertain information about the most appropriate instructional design:

Initial information questionnaires: The information questionnaires will request information relating to characteristics such as age, gender, accounting background knowledge of participants (This should take 5 minutes to complete).

- Instructional phase: Information will be presented on sheets of paper using three different formats (This should take 10 minutes).
- Testing phase:
  - Part 1 will consist of a questionnaire that is designed to test knowledge of the basic accounting equation from participants, followed by questions on the use of the accounting equation particularly showing the effect on assets, liabilities and capital (This should take 30 minutes).
  - Part 2 will consist of a questionnaire that is designed to test knowledge of the accounting ratios and their use from participants (This should take 30 minutes).

Possible Risks, Inconveniences and Discomforts

Part one of the study will take 45 minutes of your time whilst part two will also take 45 minutes. There are no foreseeable risks in this study. No-one, including the researcher, is able to connect your response to your answers. You will be providing your individual responses anonymously, and all responses will be collected at the end as a group. Your involvement in the study is voluntary and you may withdraw

from the study at any time. Refusal to participate will not affect you in any way. All information related to the students will be anonymous and you may withdraw your permission without penalty at any time.

Benefit of the Research

Studies in cognitive load theory have been conducted over twenty- five years and the benefit has been that students learn from participating in the study. It is hoped that you will learn more about processing accounting information in the context of cognitive load theory. In this study, material has been adapted from Weygandt, Chalmers, Mitrione, Fyfe, Kieso, Kimmel, Financial Accounting, 2010, pages 53-54 and pages 783-785

Ethics Review and Complaints

This study has been reviewed by the Human Research Ethics Committee of the University of Wollongong. If you have any concerns or complaints regarding the way the research is or has been conducted, you can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 4221 3386 or email rso- ethics@uow.edu.au.

If you are interested in participating in the research, a consent form is available for you to read and complete and you will be provided with the chance to discuss any questions with myself, Seedwell Sithole (+61 4 6786 9475)

Thank you for your interest in the study.

Appendix E: Consent Form

Self-Management of Cognitive Load in Accounting Within a Zimbabwean University Context.

Seedwell Tanaka Muyako Sithole

I have been given information about Self-Management of Cognitive Load in Accounting Within a Zimbabwean University Context and discussed the research project with Seedwell Tanaka Muyako Sithole who is conducting this research as part of a Doctor of Philosophy degree supervised by A/Professor Indra Abeysekera and Professor Paul Chandler in the School of Accounting, Economics and Finance at the University of Wollongong.

I have been advised of the potential risks and burdens associated with this research, which include responding to financial accounting questions, and have had an opportunity to ask Seedwell Tanaka Muyako Sithole any questions I may have about the research and my participation.

I have been advised that no-one, including the researcher, is able to connect my response to the answers. l will be providing individual responses anonymously, and all responses will be collected at the end as a group.I understand that my participation in this research is voluntary, I am free to refuse to participate. My refusal to participate or withdrawal of consent will not affect myself in any way.

If I have any enquiries about the research, I can contact Seedwell Sithole (0467869475), A/Professor Indra Abeysekera (02 4221 5072), Professor Paul Chandler (02 4221 4249) or if I have any concerns or complaints regarding the way the research is or has been conducted, I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 4221 3386 or email rso-ethics@uow.edu.au.

By signing below I am indicating my consent to participate in the research of self-management of cognitive load in accounting: A case example of university students conducted by Seedwell Sithole as it has been described to me in the information sheet and in discussion. I understand that the data collected from my participation will be used for the purpose of a doctoral thesis, and possible future publication, and I consent for it to be used in that manner.

Signed Date
..../......../.............

Name (please print)
....
Thank you for your participation. If you would want to receive any information related to this study please provide your email address below
Email address: ....

Appendix F: Pre-test Questionnaire

Please answer the following by completing the required details or placing a tick in the appropriate box.

Question 1

What is your age? ……………………………………………………………………………………………………

Question 2

What is your gender? Male ☐ Female ☐

Question 3

Your first language: English ☐ Other language (please specify) ☐

………

Question 4

How would you describe your knowledge of accounting?

Very poor ☐ Poor ☐ Fair ☐ Good ☐ Expert ☐

Question 5

Have you ever encountered the accounting equation before?

Yes ☐ No ☐

If yes, briefly explain what you know about the accounting equation

………

………

Question 6

How would you describe your knowledge of the basic accounting equation?

Very poor ☐ Poor ☐ Fair ☐ Good ☐ Expert ☐

Question 7

How would you describe your knowledge of ratios in accounting?

Very poor ☐ Poor ☐ Fair ☐ Good ☐ Expert ☐

Appendix G: Split-attention Instructional Materials for Experiment 1 – Group 1

Assets = Liabilities + Owners capital, Owner's equity

Owner's equity

Expanded Basic Equation

Assets = Liabilities + Owners capital Owners drawings Revenue Expenses

Debit/Credit CR	DR	CR	DR	CR	DR	CR	DR	CR	DR	CR	DR
Effects (-)	(+)	(-)	(-)	(+)	(-)	(+)	(+)	(-)	(-)	(+)	(+)

Expanded basic equation and debit/credit rules and effects

Explanation of each account in the accounting equation

Assets

To increase (+) the balance in the asset accounts, you debit by entering the amount on the left hand side.

To decrease (-) the balance you credit by entering the amount on the right hand side. Debits to a specific asset account should exceed the credits to that account.

The normal balance of an account is on the side where an increase in the account is recorded. Thus asset accounts normally have debit balances.

Liabilities

To increase (+) the balance in the liability accounts, you credit by entering the amount on the right hand side.

To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific liability account should exceed the debits to that account.

The normal balance of an account is on the side where an increase in the account is recorded. Thus liability accounts normally have credit balances.

Owner's equity

To increase (+) the balance in the owner's equity accounts, you credit by entering the amount on the right hand side.

To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific owner's equity account should exceed the debits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus owner's equity accounts normally have credit balances.

Owners drawings Owners drawings is increased by debits and decreased by credits. Normally the drawings account will have a debit balance.

Revenue

To increase (+) the balance in the revenue accounts, you credit by entering the amount on the right hand side.

To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific revenue account should exceed the debits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus revenue accounts normally have credit balances.

Expenses

To increase (+) the balance in the expense accounts, you debit by entering the amount on the left hand side. To decrease (-) the balance you credit by entering the amount on the right hand side. Debits to a specific expense account should exceed the credits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus expense accounts normally have debit balances

Appendix H: Integrated Learning Materials for Experiment 1 – Group 2

Assets = Liabilities + Owners capital Owner's equity

Owner's equity

Expanded Basic Equation

	Assets		= Liabilities		+ Owners capital		Owners drawings		Revenue		Expenses	
Debit/ Credit Effects	DR (+) To increase (+) the balance in the asset accounts, you debit by entering the amount on the left hand side. ………….. Debits to a specific asset account should exceed the credits to that account.	CR (-) To decrease (-) the balance you credit by entering the amount on the right hand side. The normal balance of an account is on the side where an increase in the account is recorded. Thus asset accounts normally have debit balances.	DR(-) To decrease (-) the balance you debit by entering the amount on the left hand side. The normal balance of an account is on the side where an increase in the account is recorded.	CR (+) To increase (+) the balance in the liability accounts, you credit by entering the amount on the right hand side. ………… Credits to a specific liability account should exceed the debits to that account. Thus liability accounts normally have credit balances.	DR (-) To decrease (-) the balance you debit by entering the amount on the left hand side. The normal balance of an account is on the side where an increase in the account is recorded	CR (+) To increase (+) the balance in the owner's equity accounts, you credit by entering the amount on the right hand side. ……… Credits to a specific owner's equity account should exceed the debits to that account. Thus owner's equity accounts normally have credit balances	DR (+) Owners drawings is increased by debits.	CR (-) Owners drawings is decreased by credits. Normally the drawings account will have a debit balance.	DR (-) To decrease (-)the balance you debit by entering the amount on the left hand side. The normal balance of an account is on the side where an increase in the account is recorded.	CR (+) To increase (+) the balance in the revenue accounts, you credit, by entering the amount on the right hand side. ….. Credits to a specific revenue account should exceed the debits to that account. Thus revenue accounts normally have credit balances	DR (+) To increase (+) the balance in the expense accounts, you debit by entering the amount on the left hand side. Debits to a specific expense account should exceed the credits to that account. Thus expense accounts normally have debit balances	CR (-) To decrease (-) the balance you credit by entering the amount on the right hand side ….. The normal balance of an account is on the side where an increase in the account is recorded

Expanded basic equation and debit/credit rules and effects

Appendix I: Self-management Learning Materials for Experiment 1– Group 3

The specific steps below will assist you to learn the accounting equation more effectively by making use of your working memory.

Please complete the following tasks **before** you start reading the material presented:

(a) Draw a circle around the information for each debit and credit with a pencil or pen.

(b) Draw an arrow to link it to its corresponding place on the diagram with a pencil or pen. An example has been done for you.

(c) Highlight with a highlighter, underline or number in sequence on the diagram and on the text with a pencil or pen. An example has been done for you.

Guidance on self-management.

Assets = Liabilities + Owners capital Owner’s equity Owner’s equity

Expanded Basic Equation

	Assets		=	Liabilities		+	Owners capital		Owners drawings		Revenue		Expenses	
Debit/Credit	DR	CR		DR	CR		DR	CR	DR	CR	DR	CR	DR	CR
Effects	(+)	(-)		(-)	(+)		(-)	(+)	(+)	(-)	(-)	(+)	(+)	(-)

Expanded basic equation and debit/credit rules and effects

<u>Explanation of each account in the accounting equation</u>

Assets

To increase (+) the balance in the asset accounts, you debit by entering the amount on the left hand side.
To decrease (-) the balance you credit by entering the amount on the right hand side. Debits to a specific asset account should exceed the credits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus asset accounts normally have debit balances.

Liabilities

To increase (+) the balance in the liability accounts, you credit by entering the amount on the right hand side.
To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific liability account should exceed the debits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus liability accounts normally have credit balances.

Owner’s equity

To increase (+) the balance in the owner’s equity accounts, you credit by entering the amount on the right hand side.
To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific owner’s equity account should exceed the debits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus owner’s equity accounts normally have credit balances. **Owners drawings** Owners drawings is increased by debits and decreased by credits. Normally the drawings account will have a debit balance. **Revenue**

To increase (+) the balance in the revenue accounts, you credit by entering the amount on the right hand side.
To decrease (-) the balance you debit by entering the amount on the left hand side. Credits to a specific revenue account should exceed the debits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus revenue accounts normally have credit balances.

Expenses

To increase (+) the balance in the expense accounts, you debit by entering the amount on the left hand side. To decrease (-) the balance you credit by entering the amount on the right hand side. Debits to a specific expense account should exceed the credits to that account. The normal balance of an account is on the side where an increase in the account is recorded. Thus expense accounts normally have debit balances.

Appendix J: Test Materials Experiment 1

Question 1

How much mental effort did you invest for you to learn the material? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 2

(a) Write the basic accounting equation

……..

(b) Write a name but not more than once, of a term in the accounting equation, above each T account.

(c) Write DR and CR on the appropriate side, inside each T account.

(d)How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 3

(a)Write whether a <u>Debit</u> indicates an "**increase**" or "**decrease**", and a <u>Credit</u> indicates an "**increase**" or "**decrease**" for each item below.

(i)Assets: Debit……………………….…………….Credit……………………….…………………….

(ii)Liabilities Debit………………………………………Credit……………………………………………

(iii)Owners capital Debit………………..................................Credit……………………….…………………..

(iv)Revenue Debit…………………………….................Credit………………………………………..

(v)Expenses Debit…………………………….................Credit…………….…………………………….

(b)How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 4.

(a) What are the normal balances for:

(i) Assets………………………………………. (ii) Liabilities……………………… (iii) Owners capital………………………..

(iv) Revenue…………………………………… (v) Expenses…………………………

(b)How much mental effort did you invest to answer this question? (please circle)

1------------------2------------------3------------------4-------------------5------------------6------------------7----------------8----------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 5

(a) What are the normal balances for:

(i) Cash …………………………… (ii) Accounts payable…..…………………… (iii) Interest Expense.…………………

(iv) Debtors………………………… (v) Creditors…….……………………………..

(b)How much mental effort did you invest to answer this question? (please circle)

1------------------2------------------3------------------4-------------------5------------------6------------------7----------------8----------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 6

(a) If Assets equal $65,000 and liabilities equal $25,000. What is the net worth of the business?

……

(b)How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 7

(a) Mr. A, a sole proprietor has the following:

Premises $55,000; Cash at bank $6,500; Inventory $12,500 and Creditors $5,000. What is the amount of capital?

……

(b)How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 8

(a) In May, Company X records the transaction by a debit to Accounts Receivable for $5,000 and a credit to Service Revenues for $5,000. What is the effect of this entry upon the accounting equation for Company X? Tick the appropriate box.

Assets:	Increase	Decrease	No Effect
Liabilities:	Increase	Decrease	No Effect
Owner’s (or Stockholders’) Equity:	Increase	Decrease	No Effect

(b)How much mental effort did you invest to answer this question? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 9

(a) The accounting equation is a mathematical equation. Using your algebraic skills, rewrite the equation starting with the capital.

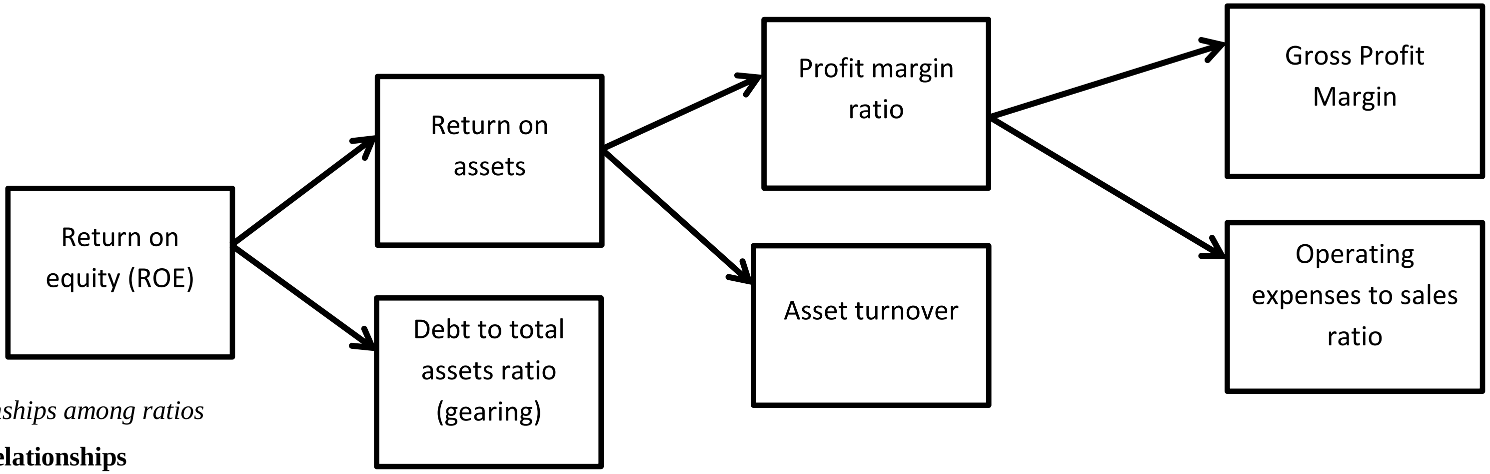
Capital = ….…………………………………………………………………..…………………………………………………….

(b) How much mental effort did you invest to answer this question? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Appendix K: Split-attention Instructional Materials for Experiment 2 – Group 1



Relationships among ratios

Ratio relationships

Financial statement analysis is used to assess an entity's financial health, both past and future. Understanding what each ratio is measuring and how the ratios interrelate assists users to answer the "why" questions. For example, any change in ROE will be attributable to changes in an entity's ROA and an entity's financial risk measured by gearing ratios. The interrelationships is shown above. These ratios together are often referred to as the Du Pont method or Du Pont Formula.

The ratios are calculated as follows:

Return on equity ratio:- Profit/Average equity: Any change in ROE will be attributable to changes in an entity's ROA and an entity's financial risk measured by gearing ratios.

Return on assets ratio:- Profit/Average assets: Measures overall profitability of assets

Profit margin ratio:- Profit/ Net sales: Measures profit generated by each dollar of sales

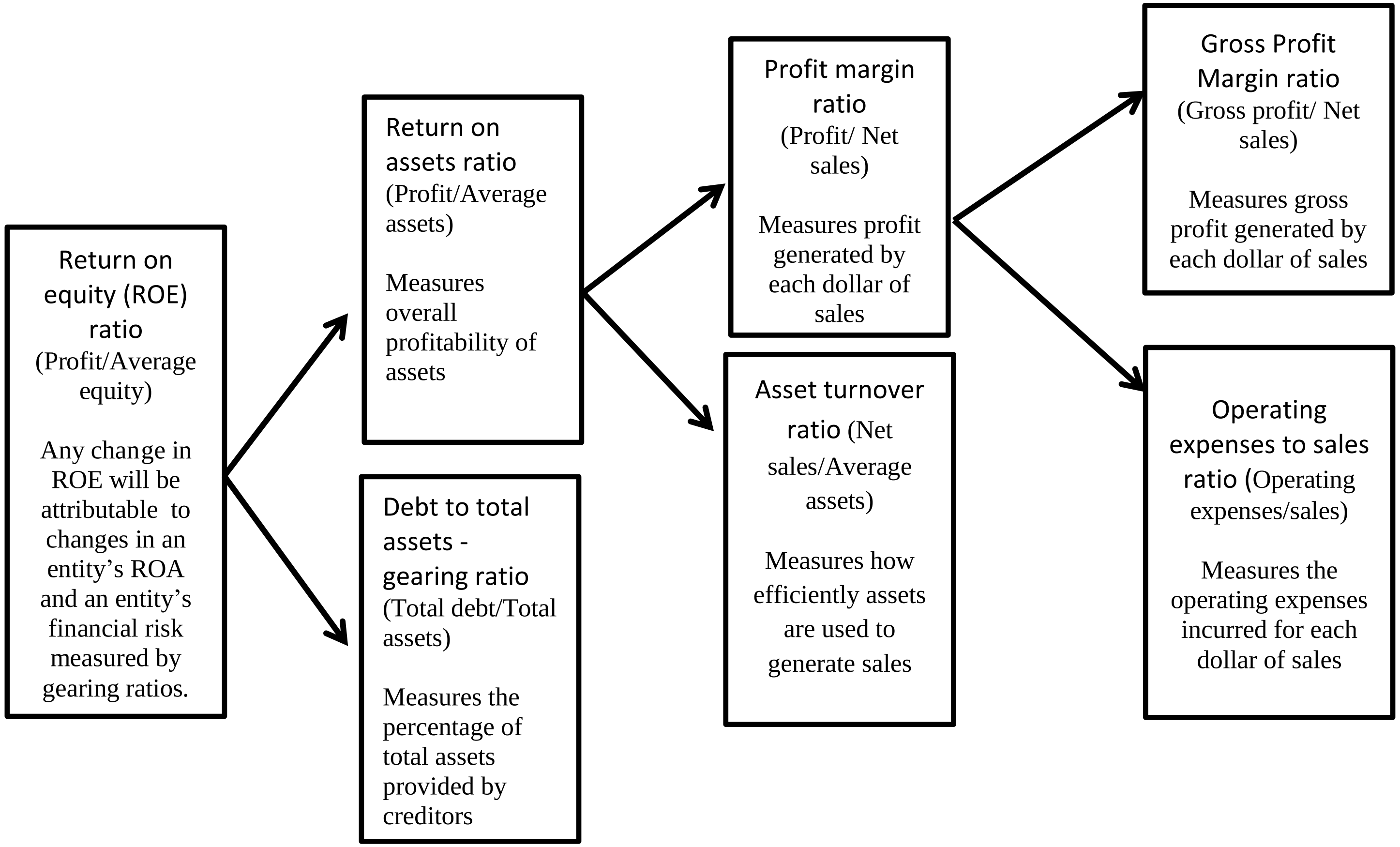
Asset turnover: Net sales/Average assets: Measures how efficiently assets are used to generate sales

Gross profit margin:- Gross profit/ Net sales: Measures gross profit generated by each dollar of sales

Operating expenses to sales ratio : Operating expenses/sales: Measures the operating expenses incurred for each dollar of sales

Debt to total assets ratio: Total debt/Total assets: Measures the percentage of total assets provided by creditors

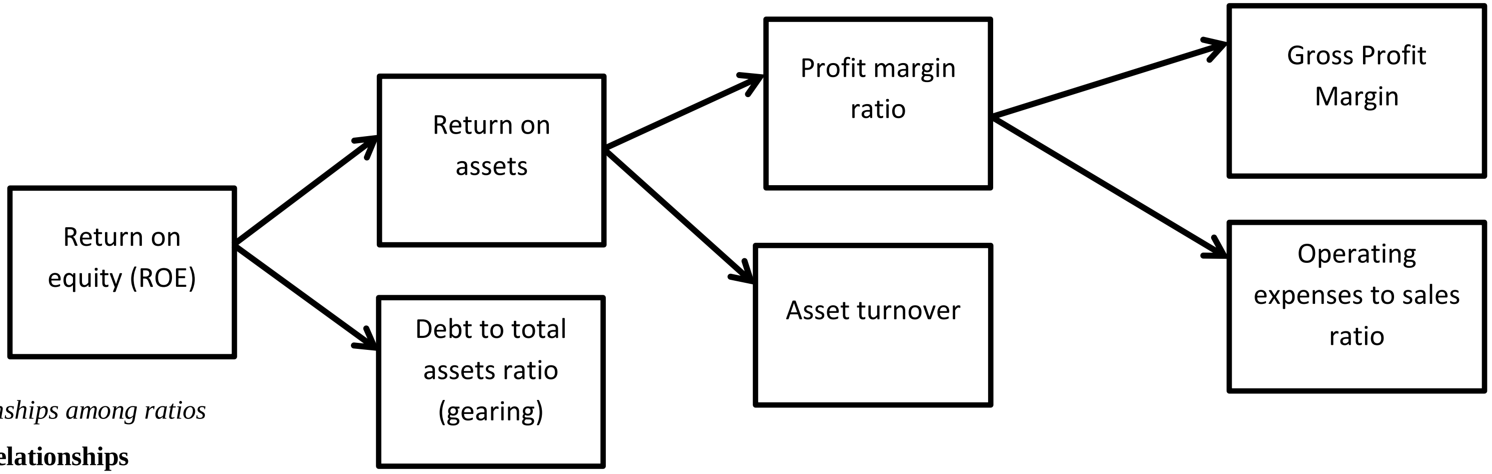
Appendix L: Integrated Instructional Materials for Experiment 2 – Group 2



Ratio relationships

Financial statement analysis is used to assess an entity's financial health, both past and future. Understanding what each ratio is measuring and how the ratios interrelate assists users to answer the "why" questions.

Appendix M: Self-management Instructional Materials for Experiment 2 – Group 3



Relationships among ratios

Ratio relationships

Financial statement analysis is used to assess an entity's financial health, both past and future. Understanding what each ratio is measuring and how the ratios interrelate assists users to answer the "why" questions. For example, any change in ROE will be attributable to changes in an entity's ROA and an entity's financial risk measured by gearing ratios. The interrelationships is shown above. These ratios together are often referred to as the Du Pont method or Du Pont Formula.

The ratios are calculated as follows:

Return on equity ratio:- Profit/Average equity: Any change in ROE will be attributable to changes in an entity's ROA and an entity's financial risk measured by gearing ratios.

Return on assets ratio:- Profit/Average assets: Measures overall profitability of assets; Profit margin ratio:- Profit/ Net sales: Measures profit generated by each dollar of sales

Asset turnover: Net sales/Average assets: Measures how efficiently assets are used to generate sales

Gross profit margin:- Gross profit/ Net sales: Measures gross profit generated by each dollar of sales

Operating expenses to sales ratio : Operating expenses/sales: Measures the operating expenses incurred for each dollar of sales

Debt to total assets ratio: Total debt/Total assets: Measures the percentage of total assets provided by creditors

Appendix N: Test Materials for Experiment 2

Question 1

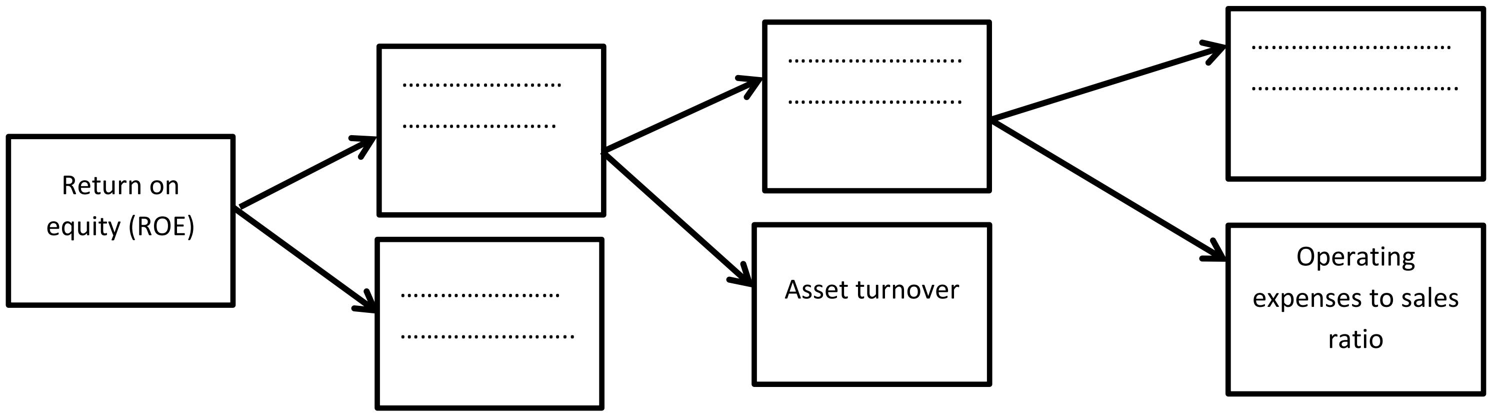
How much mental effort did you invest for you to learn the material? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 2

(a) Please complete the diagram below to provide a representation of Ratio interrelationships



(b) How much mental effort did you invest to answer this question? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 3.

(a) List the formulas used to calculate the following ratios

Return on equity ratio: …………………………………………… Return on assets ratio: ..………………………………………..

Profit margin ratio:………………………………………………… Asset turnover: …..…………………………………………….

Gross profit margin: ..……………………………………………Operating expenses to sales ratio : ..……………………………

Debt to total assets ratio: ……………………………………………

(b) How much mental effort did you invest to answer this question? (please circle)

1------------------2-----------------3-----------------4------------------5------------------6-----------------7---------------8---------------9

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 4.

(a) Selected comparative statement data for B Ltd and W Ltd are presented below. All statement of financial position data are as at 30 June 2013.

	B Ltd	**W Ltd**
Net Sales revenue	**$** 800 000	**$** 720 000
Cost of sales	480 000	440 000
Gross profit	320 000	280 000
Interest expense	7 000	5 000
Profit	60 000	42 000
Accounts receivable	120 000	100 000
Inventory	85 000	75 000
Total assets	580 000	500 000
Total ordinary shareholders equity	430 000	325 000

Calculate the following ratios for the companies:

	B Ltd	**W Ltd**
(a) Return on shareholder's equity ratio:		
(b) Return on assets ratio:		
(c) Profit margin ratio:		
(d) Asset turnover ratio:		
(e) Gross profit margin:		

(b) How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 5

(a)What do the ratios reveal about the performance of B and W Ltd?

....

....

(b) How much mental effort did you invest to answer this question? (please circle)

1	2	3	4	5	6	7	8	9
very, very low mental effort	very low mental effort	low mental effort	rather low mental effort	neither low nor high mental effort	rather high mental effort	high mental effort	very high mental effort	very, very high mental effort

Question 6

What did you do with the information on your A3 page to help you learn?

....

....

Question 7

Did you demonstrate this (what you did with the information on your A3 page) on the page?

....

....

Thank you