Using cognitive load theory compliant instructional resources to enhance learning

Abstract

In Australia, coursework satisfaction has been regularly highlighted by the national Graduate Outcomes Survey (GOS) as a critical area that requires improvement. An innovative approach to presenting instructional materials that has proved successful is the delivery of text, diagrams and other presentations in an integrated format. There has been little attention given to examining whether cognitive load theory is a useful conceptual framework to reference when designing and presenting accounting unit information on a learning management system and in tutorial discussions. We briefly describe cognitive load theory, its grounding in human cognitive architecture, and the evidence supporting it. The paper then reports the results of an investigation carried out at an Australian university, using a questionnaire, into students' perceptions of a newly designed instructional resources and tutorial presentations. The findings reveal that students are very positive about the introduction of integrated instructional materials.

Keywords: accounting, accounting education, blended learning, cognitive load theory, integrated

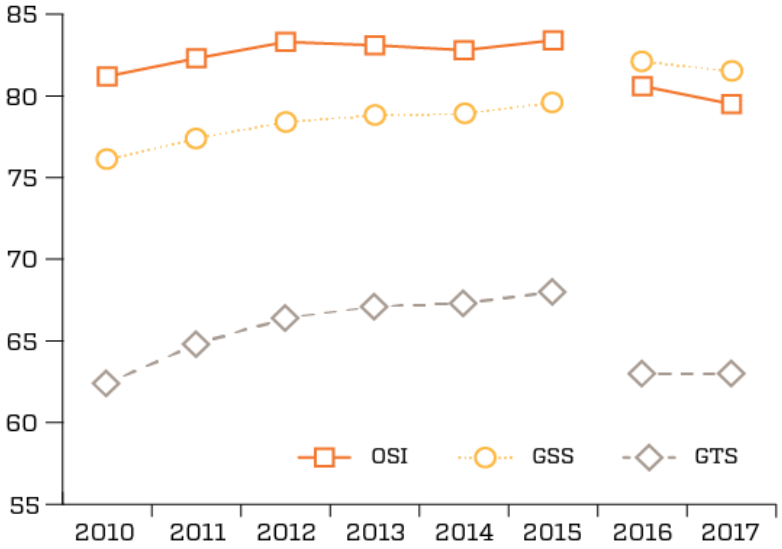
To cite this article
Sithole, S.T.M., Datt, R. (2018). *Using cognitive load theory compliant instructional resources to enhance learning*, AFAANZ Conference, Auckland, New Zealand, 3 July 2018.

1. Introduction

Since 1993, the Australian Government, as part of its quality assurance framework, invites coursework graduates to participate in a Course Experience Questionnaire (CEQ). Graduate Outcomes Survey National Report is a means of collecting information on higher education institutions, aimed at helping to inform the choices of future applicants to universities and contributing to public accountability. Since its inception, graduates within four months after completing their course express agreement or disagreement on a five-point scale with statements about various aspects that influence student learning. The areas scrutinised by the Graduate Outcomes Survey (GOS) relate to employment, skills utilisation, salaries, further study, and coursework satisfaction. Core questions on coursework satisfaction cover teaching, generic skills and overall satisfaction.

Whilst graduates' overall satisfaction has been above 79% over the eight-year period since 2010, graduates' relative dissatisfaction with the teaching compared with the other categories, is evident (Figure 1).

Figure 1: Undergraduate satisfaction, 2010–2017 (% agreement)



[1]Data are not shown prior to 2010 because of a change in survey methodology
OSI - Overall satisfaction
GSS - Generic skills scale
GTS - Good teaching scale

Figure 1 presents the CEQ time series showing an improvement in graduates satisfaction over time. In particular, overall satisfaction with courses has remained high, above 79% from 2010 to 2017. Similarly, ratings of generic skills have remained high, increasing from 76.1 per cent in 2010 to 81.5 per cent in 2017. Satisfaction with the quality of teaching has remained below 70% over the eight-year period, which highlights that this area needs the most attention. As a result, Australian Government Office for Learning and Teaching (OLT) has commissioned a series of research projects to investigate the issues and perform an analysis of the trends (e.g. Bennett, Richardson, & MacKinnon, 2016).

Several attempts by universities in Australia to enhance the quality of teaching have been negligible over the past eight years (see Figure 1). About 40% of graduates are still not satisfied with the teaching practices during their study. As Henderson, Selwyn and Aston (2017) emphasise, what works and why cannot be easily solved. Given the prolonged nature of this challenge, the key questions addressed by this paper are: How can universities develop instructional material that satisfies students? What kinds of instructional resources enhance students learning and how should they be delivered? Will the reorganisation of instructional material improve the perception of students towards their learning and teaching?. This paper tests the efficacy of reorganising accounting instructional materials for a wide range of instructional formats. Rather than applying CLT compliant instructional material in one topic, this study implemented a unit-wide change in the lecture materials, tutorial materials, and online resources for a working in professions unit.

Cognitive load theory

Cognitive load theory (CLT) provides a strong theoretical foundation for designing instruction and building knowledge and skills that can be transferred to the workplace after learning (Sweller, 2016). The central tenet of CLT (Sweller, 2017) is that human cognitive architecture should be taken into account when designing instruction. In particular, the limitations of working memory. If a learning

task increases a student's cognitive load, learning will be hampered. CLT suggests instructional designs that optimise the use of working memory capacity and avoid cognitive overload. One type of the load identified by CLT is extraneous cognitive load, which is the burden imposed on working memory due to the manner information is presented or the activities in which the learner must engage (Sweller et al., 2011). Many instructional materials exist which are not CLT compliant (Sithole et al. 2017). For example, separate diagrams and text are very difficult to understand. This form of presentation, is referred to as split-attention. It demands the student's effort to mentally reorganise the text related to the diagram (Ginns, 2006; Sithole 2017). CLT principles state that such instructional presentations are poorly designed (Sithole et al., 2017). An alternative instructional presentation called integrated format would be to have the text embedded in the diagrammatic presentation.

In an online learning environment, text, visuals, and sound can be effective tools for education. The challenge for academics is to identify the conditions under which a combination of these different media are the more effective. From a cognitive load theory perspective, such information should be presented, partly in a visual mode and partly in a verbal mode (Homer, Plass, & Blake, 2008). The underlying principle governing this CLT design principle is that humans have two separate working-memory channels: one for processing auditory information, and another one for processing visual information (Leahy & Sweller, 2011). Since each system has a limited capacity, it is possible for a system to be overloaded if more novel information is processed simultaneously. Therefore, rather than presenting, for example, a visual only a combination of audio and visual instructions may be superior (Leahy & Sweller, 2011).

Blended learning involves combining different online media with traditional teaching strategies which may result in opportunities for learners to experience cognitive overload (Chen, Woolcott, & Sweller, 2017). This paper contributes to the research that seeks to further develop blended learning

by relying upon cognitive load theory to contextualise the design of accounting instructional materials. Blended learning environments have been adopted by many universities for years (Delaney, McManus, & Ng, 2010). Suggestions have been made that such learning environments promote student-centred learning (O'Keefe, Rienks, & Smith, 2014) and encourages increased student interactions (Weil, De Silva, & Ward, 2014). However, Mostyn (2012) identified a lack of empirical studies in accounting using cognitive load theory (CLT), which identifies the cognitive constraints of novice learners when learning complex tasks and provides specific methods for improving learning efficiency. Mostyn (2012) called for more research in this area as CLT has shown potential to improve learning processes and increasing learning efficiency at any level by reducing extraneous load. Similarly, Henderson, Selwyn and Aston (2017) raised the concern that, whilst digital technology has become an integral aspect of university teaching and learning, it is important to identify the aspects of digital technology that extend and enhance students learning.

Within the context of CLT, our study examines students' perceptions regarding different presentation formats in order to establish their satisfaction. In particular, if extraneous cognitive load is reduced, CLT theorists argue that an individual's ability to understand information is enhanced hence satisfaction with the unit. Reduction of cognitive load in this study was implemented by, (1) utilising resources that avoid split-attention, which reduce extraneous cognitive load (Chen, Woolcott, & Sweller, 2017); (2) assist students by presenting videos with visuals and audio, thereby allowing them to more easily learn than presenting visuals and text. CLT's modality effect suggests that visuals in instructional material may be explained better by using audio rather than text (Liu et al., 2015); and (3) Reorganising instructional material by minimising multiple references to visuals, text and diagrams to reduce the need to search the solution steps within the text and match them with corresponding parts of the visuals or diagrams, thereby freeing cognitive resources for learning (Parte et al. 2018; Sithole et al., 2017).

This is an interesting question due to the fact that accounting standards require the presentation of certain documents in vertical format but it is very common to use horizontal formats in teaching materials. It seems that for pedagogical issues the horizontal format works better. Our arguments result in the following hypothesis:

H2. Students' perceptions of the TFV differ depending on the format used to present the financial accounting statement.

This paper makes several contributions to the accounting education literature. From a theoretical perspective, this is one of the few articles to introduce cognitive load theory into an accounting unit design incorporating a blended learning approach. Through the lens of cognitive load theory, this paper provides unique empirical evidence, which demonstrates how accounting instructors can design CLT compliant materials to improve the online and face to face learning environment and facilitate student learning. The analysis of students' perceptions suggest that CLT compliant materials are indeed an effective way to design accounting instructional material to facilitate understanding and hence improve students' satisfaction. From a practical perspective, this paper provides concrete examples and strategies of how cognitive compliant instructional materials can be used by instructors to redesign their learning resources. In this context, this paper fits within the ''design'' taxonomy of blended learning research proposed by Graham et al. (2014). This paper's contributions are timely and significant as the Australian undergraduate students' level of satisfaction has been regularly highlighted by the national Graduate Outcomes Survey (GOS) as a critical area that requires improvement, and accounting academics are combining face-to-face with online learning (e.g., Nor & Kasim, 2015; O'Keefe, Rienks, & Smith, 2014; Weil, De Silva, & Ward, 2014).

2. Blended Learning

The interactions between learners and instructors vary across online and traditional courses. In traditional courses, most of student-instructor interactions take place in a face-to-face setting within a classroom. More recently, expanded opportunities for learning include face-to-face presentations, paper-based assessments, visual material, online research and group activities. Blended learning is a combination of all of these approaches (O'Keefe, Rienks, & Smith, 2014). There are marked disagreements on the precise definition of blended learning (Bernard et al., 2014; Spring & Graham, 2017). Discrepancies across definitions range from the proportion of online learning to face-to-face instruction to the quality of the educational experience (Graham, 2013). Although the definitions of blended learning vary in scope and focus, in this study the term refers to a combination of face-to-face teaching, print based and online resources available to students that facilitate engagement with the course content.

The advent of new technologies has aided course designs that blend multiple elements of online and traditional courses. It involves a strategic and systematic approach to combining modes and times of learning, integrating the best aspects of face-to-face and online interactions using appropriate technology (Brown, 2016). In so doing, blended learning is often seen as the answer to learning and teaching problems. According to Brown (2016), blended learning has become “the new traditional model”. As Laurillard (2012) also points out that whether we like it or not, the mix of face-to-face and online is inevitably present in the learning and teaching practices of students and teachers globally. Means et al.’s (2013) meta-analyses of 45 studies revealed that some elements of face-to-face instructions are still needed for blended learning to be effective.

Another important consideration is the rationale behind blended learning. Osguthorpe and Graham (2003) claim six key goals for designing a blended learning environment: (1) pedagogical richness, (2) access to knowledge, (3) social interaction, (4) personal agency, (5) cost effectiveness, and (6) ease

of revision. According to Kintu et al. (2017) universities are to adopting blended learning approaches in response to large classes, loss of student-staff contact, meeting professional bodies interests, and inconsistency in quality between markers.

Blended learning is supposed to involve a change in paradigms whereby the focus of activity is shifted towards the learner and away from instructor teaching (Montgomery *et al.*, 2015). It is expected that shifting toward a student-learning paradigm entails the instructor moving away from being the centre of student learning and playing the role of facilitator. The instructor would be one of the multiple learning resources available to the student.

In the past, accounting instructors utilised traditional lecture approaches in their teaching, even though the effectiveness of this approach has been questioned (Aly, 2016). Many accounting instructors have been restructuring their models of teaching and moving toward a blended learning approach due to technological developments (Aly, 2016; Grabinski, Kedzior, & Krasodomska, 2015; Nor & Kasim, 2015; O'Keefe, Rienks, & Smith, 2014; Taplin, Kerr, & Brown, 2017; Weil, De Silva, & Ward, 2014).

Most research on blended learning has occurred over the past two decades. Graham et al. (2014) conducted a meta-analysis to synthesize the literature on blended learning utilising a taxonomy of explore, explain, and design for synthesizing prior literature. Graham et al. (2014) concluded that most of the literature fits within the taxonomies of explore (e.g., definitions of blended learning) and design (e.g., how to mix online and traditional pedagogical strategies in blended learning environments). There is a lack of research that seeks to understand the effect of mixing traditional and online strategies taking into account the limitations of the human cognitive architecture. As a result, this study seeks to apply cognitive load effects to blended learning. Recent graduates'

inability to rate teaching quality highly may be indicative of the need to effectively integrate multiple sources of instructional designs and materials into the learning process following CLT principle.

3. Cognitive load theory

The fundamental tenet of cognitive load theory (Mostyn, 2012; Sithole & Abeysekera, 2017; Sweller, 2017) is that human cognitive architecture should be taken into account when designing instruction. Cognitive load theory (CLT) is an instructional theory which recognises that working memory has a limited capacity of seven plus or minus two elements (or chunks) of information when merely holding information (Miller, 1956) and even much less when processing information (Cowan, 2001). CLT is concerned with methods for reducing working memory load in order to facilitate the changes in long-term memory associated with knowledge acquisition (Leppink et al., 2014). The long-term memory that has a virtually unlimited capacity holds information stored in schemas (Paas, Renkl, & Sweller, 2016). Once schemas have been acquired and automated, they can be handled in working memory with very little conscious effort and can reduce working memory load. In addition, regardless of how extensive a schema is, it will be treated as one chunk of information. This allows the amount of information that can be held and processed in working memory to be increased without requiring more conscious effort. Sufficient cognitive capacity will then be available to solve very complex problems (Paas, Renkl, & Sweller, 2016). Conversely, when schemas have not yet been acquired, all elements of information have to be kept in working memory as separate items, which might lead to an excessive demand on working memory capacity. Consequently, there would not be enough capacity left for the information processing, and learning would be hindered.

CLT is concerned with the instructional implications of the interaction between information structures and cognitive architecture problems (Paas, Renkl, & Sweller, 2016). Enabling the changes in long-term memory associated with schema construction and automation can be done by designing learning materials in a way that manages working memory load. CLT techniques aim at

minimising extraneous cognitive load. Extraneous cognitive load arises from instructional methods that require the learner to engage in cognitive processes that do not contribute directly to the construction of cognitive schemata. For example, having to mentally integrate spatially or temporally separated but mutually referring information sources. Such processes are unnecessary and extraneous to the learning goals (Leppink et al., 2014). Another type of load recognised by CLT is intrinsic cognitive load, which is determined by the intrinsic nature of the information to be learned. A key feature is the number of interacting information elements that the learning task or the learning material comprises (Blayney, Kalyuga, & Sweller, 2016; Chen, Kalyuga, & Sweller,2017; Sweller, 2016). Students who have little prior knowledge of the learning material, have to process interacting elements in order to learn the material. As learning progresses, the information elements become incorporated into cognitive schema stored in long-term memory, which can be handled as one single element in working memory. Therefore, the intrinsic cognitive load that is imposed by learning materials is much higher for novices than for more advanced students. A later addition to the cognitive load framework was the concept of germane cognitive load (Sweller, 2016). This type of load arises from relating relevant information from long-term memory to the new information elements (Leppink et al., 2014).

4. Cognitive load theory, instructional design materials, and blended learning

According to the basic principles of CLT, instructional design rest upon the argument that extremely high levels of cognitive load may result directly from the instructional materials presented to students. In addition, redesigning instructional materials to reduce the levels of extraneous cognitive load may enhance learning. The content areas that are more likely to demonstrate beneficial results from improved instructional design are those that deal with complex information where the elements of to-be-learned information interact with one another, thereby imposing a high level of intrinsic cognitive load (Mason, Cooper, & Wilks, 2015, Sweller, 2017). CLT seeks to enhance student

learning by raising the quality of instructional design, giving greater consideration to the role and limitations, of working memory.

Given the significance of designing high quality instructional materials, it is important to highlight that instructors often utilise materials that have been created by third parties, such as textbook authors and curriculum designers. Consequently, there is a possibility that accounting instructional materials were created with an intended learning objective that is not the same as that of the instructor. Such an environment may create a hybrid of the instructor's intent and the unintended impact of the instructional design material.

Blended learning incorporating CLT principles can enhance learning by providing students with various opportunities to experience a range of accounting instructional materials designed with human cognitive architecture in mind. Furthermore, given that the instructor can facilitate the management of instructional material (Sithole, Chandler, Abeysekera, & Paas, 2017), the design of CLT compliant instructions is made in such a way that it does not "overload" their mental capacity, which CLT theorists argue promotes learning (Sweller, 2017).

5. Overview of the current study

Coursework satisfaction has been frequently highlighted by the national Graduate Outcomes Survey (GOS) as an important area that requires improvement. This low satisfaction is reported in a learning environment combining face-to-face presentations, paper-based assessments, visual material, online research and group activities. While this blended learning environment has become an integral aspect of university teaching and learning, it is important to establish whether incorporating cognitive load theory in the design and teaching of university students enhances learning.

In 2017, we developed a unit with face to face and an online component called working in professions. As part of the instructional model, the instructors spent more time with students on group and individual discussions. Instructors would guide, explain, and challenge students in order to extend their knowledge and understanding of the subject matter. Lecture content was delivered online for students to study outside the classroom. During class time discussions and other active learning activities took place. The online component comprised of mini-lectures created by the instructors and posted on the unit learning management system (LMS). A mini-lecture would essentially consist of the instructor presenting on a topic, and creating a five-to ten-minute video. The video consisted of an oral presentation. The mini-lectures were created on a wide variety of topics relevant to the working in professions unit. Examples include the meaning of work and the global workplace, accounting professional bodies and ethics. The mini-lectures were used as a replacement for a traditional lecture and used as an integral resource for tutorial discussions.
For every topic, the mini-lectures were supplemented by three separate videos. After watching each video, students were asked to respond to two or three questions before proceeding to the next video. For example, students were asked what set of responses they would carry out if they were confronted with a similar situation in their workplace. After each choice was made, the instructional material were programmed to show possible solutions. This model is similar to most blended learning units in the discipline of accounting (Asarta & Schmidt, 2017).

In this study, we discuss the strategies for incorporating CLT compliant materials into the teaching of accounting and evaluate the related benefits. Unit observations are presented based on an analysis of student usage and a questionnaire obtaining information about the effectiveness of the strategies.

6 Method

6.1 Ethics approval and assumption

This study was conducted at an Australian university. Ethical approval for the study was obtained from the Human Research Ethics Committee at the Australian university. The investigation was conducted in the School of Business over a period of two sessions (autumn and spring). The assumption of this investigation was that the integration of cognitive load theory into the instructional materials and teaching approaches is related to the students' perceptions of teaching and learning in the unit.

6.2 Participants and design

One hundred and five students from a working in professions unit participated voluntarily in the study in 2017. Study participants were enrolled in a blended learning unit. Students were recruited from the autumn and spring offering of 2017. The researchers explained the aims and method of the study to the students at each time point of the study. Students were informed that participation was voluntary and that the results from the study were not part of the subject's assessment, and that data would be collected anonymously. Students signed consent forms stating their written agreement to take part in the study. The autumn class was the control group while the spring class was the experimental group. Confidentiality was maintained through the use of code numbers when storing data.

6.3 Strategies for incorporating CLT compliant materials into the accounting unit.

There were different scenarios involved for incorporating cognitive load theory in students' learning and how CLT compliant instructional materials and classroom management were used to enhance learning. The data collection used a student perception survey questionnaire delivered online and included response items derived from CLT compliant and non-compliant materials. The unit was

taught before developing CLT compliant materials in autumn and CLT compliant materials were incorporated into the blended learning unit during spring.

The unit was the same in all respects (unit content, same instructors etc.) except that during spring, instructional resources that took into account cognitive load theory recommendations were introduced. The areas investigated were examined on the basis that they were the functional attributes used in the learning management system (LMS) implemented by the university.
There are different scenarios that may involve cognitive overload in students' learning (Bradford, 2011). Learners may process visual content that may overload their cognitive capacity. For example, when a learner is viewing an animation, while concurrently reading text describing what is taking place in the visual presentation. In another situation, learners may not process information quickly enough when there is a combination of auditory and visual information. For example, when there is an animation that is presenting concepts with accompanying explanatory text at a fast rate. In a third situation, both visual and textual channels may be overloaded due to the processing of non-essential and essential information. For example, a learner might be working to learn the accounting equation while being distracted with instructional content related to the preparation of an income statement. In the fourth situation, the learning task is presented in such a way that the learner has to split his or her attention in order to integrate and understand the content. For example, a student having to process instructional material with explanatory text that is not in close proximity to the diagram. In the fifth situation, a learner is required to hold multiple pieces of information in working memory while trying to mentally integrate new instructional material. The limitation of human working memory would not have the capacity to process any new information. These five scenarios were taken into account in the design of a working in professions unit.

The following section elaborates on how CLT compliant instructional materials and classroom management were used to enhance learning.

6.4 Online Lectures

The autumn and spring online lectures were different. What was different was that the instructional design for spring was based on the CLT conceptual framework, aiming to facilitate and enhance students' learning. For example, students viewed a particular segment of a video that allowed them to engage in discussion based on viewing the authentic video footages before moving to the next video. Students were immediately able to choose what they would do and see the results of their chosen actions before proceeding to the next resource. During autumn, students would see a continuous video presentation. Besides the fact that known practitioners in accounting and other business areas provided inspiration for our students, the spring material was presented in a way that allowed each resource to be intelligible on its own. According to CLT, instructional material that requires learners to mentally integrate disparate sources of mutually referring information, such as text and diagrams or multiple related items interferes with learning by misdirecting attention and imposing a heavy cognitive load (Sithole, 2017). The multiple referencing of information was significantly reduced from the autumn to spring sessions. For example, there was an average of five links to other sources of data in autumn and these were presented separately during the spring session.

Listening to audio and watching video at their own pace, during their own time replaced lectures, and provided students with a unique learning opportunity. For example, there was much more time for the students to study and learn outside the class, and videos allowed students to absorb the instructional material in many different manners (Cardullo, Wilson, & Zygouris-Coe, 2017). This was the same for both autumn and spring sessions. Aside from merely increasing the number of opportunities for students to experience variation in their learning, spring videos were structured to make them easier for students to engage with the materials. Specifically, visual presentations of a task in a video had audio narration that explained the concepts and no competing textual information which would overload the students. The autumn videos had textual information, which

was eliminated during the spring session. A CLT principle, modality, suggests that visuals in a material may be explained better by using audio rather than text (Liu et al., 2015).

6.5 In class activities

The results in multimedia research suggests that extraneous cognitive load appeared not only from design features of materials such as videos, but also the delivery settings (Çakiroğlu & Aksoy, 2017). In tutorial discussions, we offered a step-by-step discussion in group format, stimulating students to think about how they would proceed if they were in a real business environment. From the online practical business cases, detailed questions on each part of the video were used to foster the discussion of various business scenarios. Both the autumn and spring sessions involved discussions. During autumn, content on different topics was discussed simultaneously and could be summarised at any point in time. However, during spring presenting and discussing the content in a step by step fashion allowed for the elimination of a split-attention effect, reducing cognitive load by allowing one resource to be analysed at a time and discussing the complex whole at the end (Sithole *et al.*, 2017).

The split-attention effect affect learners when distractions are present in the learning environment. The classrooms that we used were at a vertical campus with well-defined physical arrangement and were well organised. A student could easily move in and out of the class using multiple entrances. Students were encouraged to be co-operative and quiet unless they were contributing to discussions. Another main feature of the spring class was that students would work out a task in groups and then could instantaneously share their findings to the other groups using a computer share tool. This computer-based media tool was appropriate because it enabled students to reflect and express their views in a way that enabled normally quieter students to express their views freely and openly at every stage. Sharing information instantaneously allowed students access to different views rather than at a later stage after completing other tasks. Instructors giving presentations

during tutorial classes ensured that they did not stand next to distracting signs, posters or written work during spring. Any written work left on the walls during a prior class was quickly erased before the start of the tutorials. During autumn, before the embedding of CLT, `this was not consciously done. By identifying and removing all stimuli, which had the potential to distract students during spring, instructors reduced the additional extraneous cognitive load imposed on the learners (Sweller, 2016).

6.6 Evidence of effectiveness

Classroom data analyses were used to assess the efficacy of the CLT compliant instructional materials. The unit analyses were based on student usage data stored on the unit LMS. Both the results of the control group (blended learning classroom without CLT compliant materials) and an experimental group (blended classroom design with CLT compliant materials) were analysed. Statistics were obtained from the working in professions class over two teaching sessions during 2017. The course is mandatory for all business students. The vast majority of the students had one year of university experience.

First, data from the unit LMS provided insights into usage patterns among the different cohorts. Second, students' perceptions were analysed to provide explanations of the efficacy of CLT compliant instructional materials. The study ruled out any differences in the control group and experimental group through an analysis of students' age, assignment access times and video viewing times. The profile of all students who participated in the study are shown in the Table I.

Table I. Descriptive statistics of demographic data and the use of the LMS tools

Demographic characteristic/Tool	Autumn class (n=54) (mean) *SD/%*	Spring class (n=51) (mean) *SD/%*	Test of equality (*p*-value)/Total
Age	(20.37) 2.71	(19.68) 2.13	.15
Assignments access	(3.59) 1.90	(3.75) 1.93	.68
Video viewing times	(44.93) 13.82	(48.76) 11.99	.13
Perception questionnaire	54 (51.43%)	51 (48.57%)	105(100%)
Gender of respondents			
Female	21 (20.00%)	23 (21.90%)	44 (41.90%)
Male	33 (31.43%)	28 (26.67%)	61 (58.10%)
Mode of study(no):			
Full-time	51 (48.57%)	49 (46.67%)	100 (95.24%)
Part-time	3 (2.86%)	2 (1.90%)	5 (4.76%)
Major(no):			
Accounting	38 (36.19%)	36 (34.29%)	74 (70.48%)
Non-accounting	16 (15.24%)	15 (14.29%)	31 (29.52%)

Table I presents the average number of users who accessed each tool included in the LMS and some descriptive statistics of the demographic characteristics of participants in the two groups. There were no significant difference in the descriptive statistics of the use of the LMS tools.

T-tests were used to investigate any differences between the experimental and control groups. Table I shows the analysis to check equivalency between the groups. As shown in Table I, the two groups were equivalent in terms of extraneous variables tested. The t-test revealed no significant main effect of group for age; $t(2, 103) = 1.43$, $p = .15$, assignment access $t(2, 103) = .41$, p .68, and Video viewing times $t(2, 103) = .13$, p .13.

The classroom statistics for both the LMS data and student surveys are based on a blended learning classroom with CLT compliant materials (spring group) and a blended classroom design without CLT compliant materials (autumn group). Short video viewing averaged 44 to 49 views in total for the whole session. In both situations, the instructor's goal was to free up class time in order to introduce active learning strategies that focus on higher-order skills. The instructional materials differed only in their design. In both groups, more than 70% the students were accounting majors, with the

remaining 30 percent majoring in finance and economics. Research ethics approval was obtained from the university in order to ensure that the satisfaction survey and analysis of the students data were consistent with ethical standards.

6.7 Analysis of Student Surveys and discussion

The data from the unit LMS suggest that CLT compliant instructional material is associated with higher student satisfaction with the learning material. However, we obtained further insights from the students' surveys. A student perception survey was administered with the purpose of exploring the students' attitudes towards the unit. The survey participation was anonymous and voluntary. One hundred and three students responded to the survey. It was administered at the end of each teaching session. The survey consisted of seven questions. The first five questions asked students to rate the statements. The last two questions were open ended. To measure effect size, Cohen's *d* was calculated, with values of .10, .30, and .50 characterizing small, medium, and large effect sizes, respectively (Cohen, 1988).

Students were first asked to rate statements on a Linkert scale whereby ''1'' was ''strongly disagree'' and ''5'' was ''strongly agree.'' Table 1 presents the results from the Likert scale rating on the survey instrument.

As shown in Table II, one-way ANOVA for watching mini videos showed a significant main effect between the autumn and spring groups; $F(1, 101) = 2.93$, $p < .05$. The spring blended + CLT group reported significantly higher rating than autumn blended + traditional group, $d = .53$, indicating a large effect size. It is interesting to note that both groups of students preferred the mini lecture videos in future, and no significant differences were detected; $F(1, 101) = 2.93$, $p = .14$. Consistent with our expectations, the autumn blended + CLT group reported significantly higher ratings on whether videos helped to integrate and clarify the interrelationships than the autumn blended +

traditional group, $F(1, 101) = 3.59$, $p < 0.05$. $d = .6$, indicating a large effect size. The one-way ANOVA for item 4: 'tutorial learning strategies stimulated me to learn,' also demonstrated a significant main effect of group; $F(1,101) = 4.53$, $p < .05$, and a large effect size $d = .78$, with the spring blended + CLT group reporting a significantly higher rating than the autumn blended + traditional group. In terms of satisfaction with all the videos and text materials provided in the unit, the spring blended + CLT group reported a significantly higher satisfaction $F(1, 101) = 4.31$, $p < .05$. $d = .71$, indicating a large effect size.

Table II. Survey Responses to Rating Questions

Survey question	Autumn class (n=53) Mean	Spring class (n=50) Mean	Test of equality (*p*-value)
1. Mini lecture videos helped me to understand	3.15	3.78	$p < 0.05$ [a]
2. I would like to see more mini lecture videos in the future	4.25	4.52	.14
3. Supplementary videos helped me integrate and clarify the interrelationships	3.38	4.18	$p < 0.05$ [a]
4. Tutorial learning strategies stimulated me to learn	3.25	4.24	$p < 0.05$ [a]
5. I was satisfied with all the videos and text materials provided in this unit	3.09	4.10	$p < 0.05$ [a]

[a]Significant at the 0.05 level (two-tailed)
Scaling of survey 5 point scale (1=strongly disagree, 5= strongly agree)

Table II suggests that students were more satisfied with learning from watching the mini-lecture videos during spring than autumn. The mini lecture videos were redesigned during the spring session to align with CLT principles. Similarly supplemental resources such as other videos and written text were preferred more than the traditional resources offered in the blended mode during autumn session. It appears students prefer CLT compliant resources since the majority stated that they would want to see more resources of this nature in the future.

There were two qualitative, open-ended questions at the end of the survey. The first question asked the participants to state the best and worse features of the mini-lecture videos. The participants responded on two columns. In the first column, they stated the best features and in the second column, the worst features. The second question asked students to state why they found the videos useful.

All of the participants' responses were grouped after review. The following seven themes emerged from the student responses (in the order of most responses to least responses per theme).

Table II. Responses to open ended questions

	Participants' response	No	%
1	The videos could be viewed at my own time and pace.	85	28%
2	The videos could be viewed multiple times.	64	21%
3	The videos were interesting.	58	19%
4	Videos were brief and directly related to solving the problem presented without any distractors.	36	12%
5	The questions embedded in the videos allowed me to understand better.	28	9%
6	The videos were specific to our class as they had the instructor's presence.	21	7%
7	The videos were more interesting than reading.	17	6%
	Total	309	100%

The seven themes were further categorised according to the benefits of using mini videos that are CLT compliant while other benefits emerge inherently from using any type of video in the classroom. Figure 2 illustrates this categorisation.

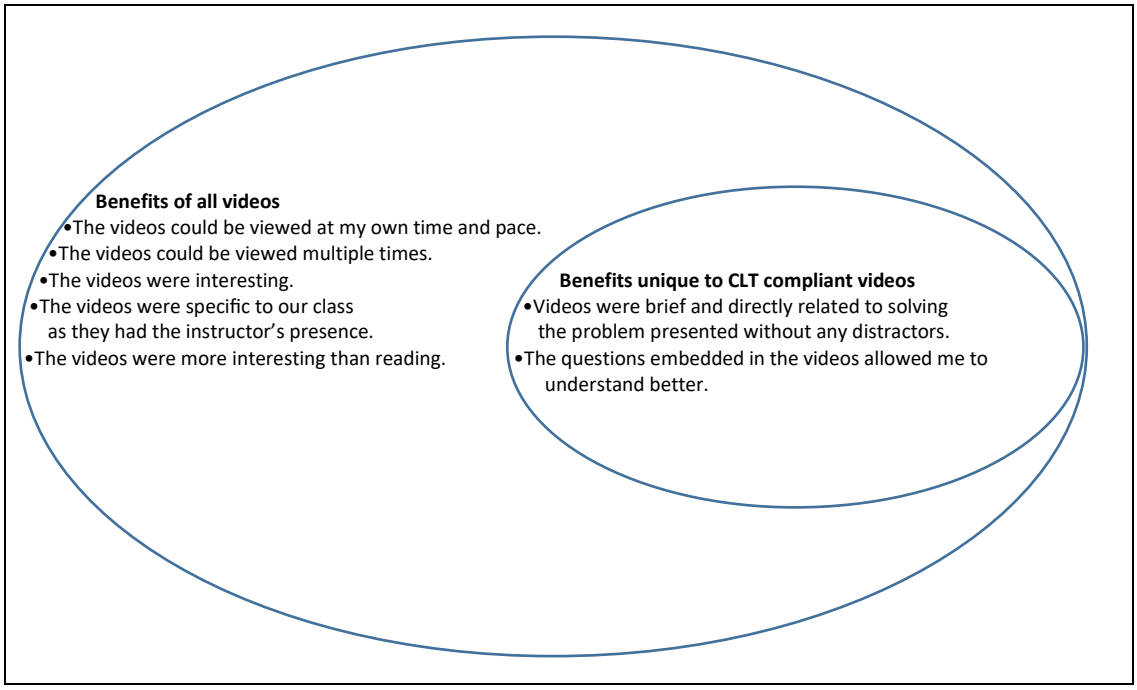


Figure 2. Benefits to all videos and those unique to CLT compliant videos

It is apparent from the themes that although the vast majority of the responses reported essential benefits from all videos, the participants stated additional benefits from CLT compliant videos. For example, the participants benefited from videos that were brief and directly related to solving the problem presented without any distractors. This is consistent with the arguments presented in this paper that CLT compliant instructional materials enhance learning. For example, participants found the videos useful for their learning because of the following features: ''questions embedded in the videos,'' and ''no distracting information.'' Therefore, participants greatly benefited from questions embedded in the videos which allowed the students to understand the videos better. The videos were also brief and directly related to solving problems. These themes were ranked fifth and sixth in terms of the number of responses. These two themes are important as they suggest that CLT compliant videos are useful for blended learning classroom designs. Another interesting response was that the students liked the videos being specific to the classroom setting with the instructor

being a major participant as opposed to any other videos such as YouTube videos that are more general in nature.

In terms of the things that the students disliked, the students stated the following: Internet connectivity resulting in delays with viewing the videos; hard to read the text on one of the linked resource. The major undesirable comments were on technological issues related to home internet connections while participants attempted to watch the mini-lecture videos. There were no negative perceptions on the pedagogical issues of the CLT compliant or non-compliant resources that occurred frequently enough to be considered a theme.

In summary, the number of beneficial features vastly outnumbered the comments of negative features for both blended learning with traditional resources or blended learning with CLT compliant resources. Most of the negative comments were related to technological issues. On the other hand, most of the positive comments were related to the pedagogical efficacy of CLT compliant resources. Specifically, the frequent comments were mostly related to the videos that were ‘‘brief and to the point’’ and working through the concepts systematically on a step-by-step basis with ‘‘questions embedded in the videos.’’

There are numerous benefits of developing and utilising CLT compliant instructional materials. First, the use of these materials in a blended learning environment provides instructors with opportunities to manage the load presented by the instructional materials to learners in order to enhance their learning (Grangeia, *et al.*, 2016). Utilising instructional materials that comply with CLT design principles will enhance the processes involved in learning, and will ultimately affect the students' level of satisfaction (Bradford, 2011). The use of own online resources reduced reliance on third parties as the creators of the instructional design materials that are utilised in the learning environment. The control afforded to instructors by this strategy allowed for the development of

tailored content to meet the specific needs of the working in professions class. This is in complete contrast to the inflexibility of online materials that are available from textbook publishers or posted on YouTube, which may not be modified by the instructor. Finally, the use of videos also enabled the development of different instructional design materials that helped to reinforce the emphasis of a student-centered learning. For example, instructors can also have students prepare videos that meet specific CLT criteria, which are then shared with the entire class.

7. Summary and conclusion

The purpose of this paper is to describe the use of CLT compliant instructional materials as a way of enhancing students' learning and increasing satisfaction. The CLT's application was demonstrated for various resources, such as mini-lecture videos, tutorial presentations with negligible distractions, and text presentations with minimal links to other resources. Utilising cognitive load theory as a theoretical framework reveals various pedagogical benefits of adopting CLT to develop instructional design materials in accounting. The various benefits are substantiated through the examination of data obtained from the unit LMS and a student perception survey. In summary, adopting CLT compliant instructional materials can (1) help students to have an in-depth understanding of the instructional material by utilising resources that avoid split-attention, which reduce extraneous cognitive load (Chen, Woolcott, & Sweller, 2017); (2) assist students by presenting videos with visuals and audio, thereby allowing them to more easily learn than presenting visuals and text. CLT's modality effect suggests that visuals in instructional material may be explained better by using audio rather than text (Liu et al., 2015); and (3) Reorganising instructional material by minimising multiple references to visuals, text and diagrams reduces the need to search the solution steps within the text and match them with corresponding parts of the visuals or diagrams, thereby freeing cognitive resources for learning (Sithole, Chandler, Abeysekera, & Paas, 2017). This also directly reinforces blended learning's paradigm shift toward a more student-centered learning approach.

The analysis of students responses reveals a positive association between the use of CLT compliant resources and students' satisfaction levels in tutorial tasks, which are perceived to be a function of the aforementioned benefits postulated by cognitive load theory. Future researchers are encouraged to further test CLT compliant instructional materials in other areas such as taxation, auditing, management accounting and non-accounting subjects. Currently, it is clear that the use of CLT compliant instructional material may facilitate the learning process and increase students' satisfaction.

References

Aly, I. (2016). Comparison of students' performance in a managerial accounting course taught in blended learning, traditional classroom, and online setting. *Quarterly Review of Business Disciplines*, *2*(4), 325-336.

Asarta, C. J., & Schmidt, J. R. (2017). Comparing student performance in blended and traditional courses: Does prior academic achievement matter?. The Internet and Higher Education, 32, 29-38.

Bennett, D., Richardson. S., and MacKinnon, P., (2016). *Enacting strategies for graduate employability: How universities can best support students to develop generic skill Part A*. Canberra, ACT: Australian Government, Office for Learning and Teaching, Department of Education and Training (http://www.olt.gov.au/project-how-universities-can-best-support-students-develop-generic-skills-enacting-strategies-gradua).

Bernard, R. M., Borokhovski, E., Schmid, R. F., Tamim, R. M., & Abrami, P. C. (2014). A meta-analysis of blended learning and technology use in higher education: from the general to the applied. *Journal of Computing in Higher Education*, *26*(1), 87-122.

Blayney P, Kalyuga S and Sweller J. (2016). The impact of complexity on the expertise reversal effect: experimental evidence from testing accounting students, *Educational Psychology*, *36*(10), 1868-1885.

Bradford, G. R. (2011). A relationship study of student satisfaction with learning online and cognitive load: Initial results. The Internet and Higher Education, 14(4), 217-226.

Brown, M. G. (2016). Blended instructional practice: A review of the empirical literature on instructors' adoption and use of online tools in face-to-face teaching. *Internet and Higher Education*, 31, 1-10.

Çakiroğlu, Ü., & Aksoy, D. A. (2017). Exploring extraneous cognitive load in an instructional process via the web conferencing system. Behaviour & Information Technology, 36(7), 713-725.

Cardullo, V. M., Wilson, N. S., & Zygouris-Coe, V. I. (2017). Enhanced student engagement through active learning and emerging technologies. *Student Engagement and Participation: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications*, 399.

Cohen, J. (1988), Statistical Power Analysis for the Behavioral Sciences, 2nd Edition. Hillsdale, N.J.: Lawrence Erlbaum.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, *24*(1). 87-113.

Chen, O., Woolcott, G., & Sweller, J. (2017). Using cognitive load theory to structure computer-based learning including MOOCs. Journal of Computer Assisted Learning. *Journal of Computer Assisted Learning*, 33,293–305

Delaney, D., McManus, L., & Ng, C. (2010). A blended learning approach to teaching first year accounting. Proc. ICERI 2010Conference, 4019-4020.

Ginns, P. (2006). Integrating information: A meta-analysis of the spatial contiguity and temporal contiguity effects. Learning and Instruction, 16, 511–525.

Grabinski, K., Kedzior, M., & Krasodomska, J. (2015). Blended learning in tertiary accounting education in the CEE region - A Polish perspective. *Accounting & Management Information Systems / Contabilitate Si Informatica De Gestiune*, *14*(2), 378-397.

Graham, C. R. (2013). Emerging practice and research in blended learning. *Handbook of distance education*, 3, 333-350.

Graham, C.R., Henrie, C.R., & Gibbons, A.S. (2014). Developing models and theory for blended learning research. In A.G. Picciano, C.D. Dziuban, & C.R. Graham (Eds.), Blended learning: Research perspectives (Vol. 2, pp. 13-33). New York, NY: Routledge.

Grangeia, T. D. A. G., de Jorge, B., Franci, D., Santos, T. M., Setubal, M. S. V., Schweller, M., & de

Carvalho-Filho, M. A. (2016). Cognitive load and self-determination theories applied to E-learning: impact on students' participation and academic performance. *PloS one*, *11*(3), e0152462.

Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of 'useful' digital technology in university teaching and learning. *Studies in Higher Education, 42*(8), 1567-1579. doi:10.1080/03075079.2015.1007946

Homer, B. D., Plass, J. L., & Blake, L. (2008). The effects of video on cognitive load and social presence in multimedia-learning. *Computers in Human Behavior*, *24*(3), 786-797.

Kintu, M. J., Zhu, C., & Kagambe, E. (2017). Blended learning effectiveness: the relationship between student characteristics, design features and outcomes. *International Journal of Educational Technology in Higher Education, 14*(1), 7.

Laurillard, D. (2012). Teaching as a design science. New York, NY: Routledge.

Leahy, W., & Sweller, J. (2011). Cognitive load theory, modality of presentation and the transient information effect. Applied Cognitive Psychology, 25(6), 943-951.

Leppink, J., Paas, F., Van Gog, T., van Der Vleuten, C. P., & Van Merrienboer, J. J. (2014). Effects of pairs of problems and examples on task performance and different types of cognitive load. Learning and Instruction, 30, 32-42.

Liu, T. C., Lin, Y. C., Gao, Y., Yeh, S. C., & Kalyuga, S. (2015). Does the redundancy effect exist in electronic slideshow assisted lecturing?. *Computers & Education*, *88*, 303-314.

Means, B., Toyama, Y., Murphy, R. F., & Baki, M. (2013). The Effectiveness of Online and Blended Learning: A Meta-Analysis of the Empirical Literature. Teachers College Record, 115(3),

Miller, G. (1956). The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. *The Psychological Review,* 63, 81-97, 10.1037/0033-295X.101.2.343

Montgomery, A. P., Hayward, D. V., Dunn, W., Carbonaro, M., & Amrhein, C. G. (2015). Blending for Student Engagement: Lessons Learned for MOOCs and Beyond. *Australasian Journal of Educational Technology, 31*(6), 657-670.

Mostyn, G. R. (2012). Cognitive load theory: what it is, why it's important for accounting instruction and research. *Issues in Accounting Education*, *27*(1), 227-245.

Nor, A. M., & Kasim, N. A. (2015). Blended Learning Web Tool Usage among Accounting Students: A Malaysian Perspective. Procedia Economics And Finance, 31(International Accounting and Business Conference 2015, IABC 2015), 170-185. doi:10.1016/S2212-5671(15)01144-2

O'Keefe, P., Rienks, J. H., & Smith, B. (2014). Use of Resources, People and Approaches by Accounting Students in a Blending Learning Environment. *Journal Of University Teaching And Learning Practice, 11*(3),1-16.

Paas, F., Renkl, A., & Sweller, J. (Eds.). (2016). *Cognitive load theory: A Special issue of educational psychologist*. Routledge.

Parte, L., Garvey, A. M., & Gonzalo-Angulo, J. A. (2018). Cognitive Load Theory: Why It's Important for International Business Teaching and Financial Reporting. *Journal of Teaching in International Business, 29*(2), 134-160.

Sithole, S. T. M. (2016), The Effects of Presentation Formats on Understanding Financial Accounting: An Experimental Study, *Australasian Accounting, Business and Finance Journal 10* (2), 76–92.

Sithole, S.T.M. (2017).Enhancing students understanding of introductory accounting by integrating split-attention instructional material, *Accounting Research Journal*, *30* (3) 283-300.

Sithole, S.T.M., Chandler, P., Abeysekera, I., & Paas, F. (2017). "Benefits of Guided Self-Management of Attention on Learning Accounting", Journal of Educational Psychology, 109 (2) pp. 220-232. doi:10.1037/edu0000127 ISSN 0022-0663

Spring, K. J., & Graham, C. R. (2017). Thematic Patterns in International Blended Learning Literature, Research, Practices, and Terminology. Online Learning, 21(4), 337-361.

Sweller, J. (2016). Working memory, long-term memory, and instructional design. *Journal of Applied Research in Memory and Cognition, 5*(4), 360-367.

Sweller, J. (2017). The role of independent measures of load in cognitive load theory. In Zheng R.Z

(ed.) *Cognitive Load Measurement and Application: A Theoretical Framework for Meaningful Research and Practice*. Routledge, New York:NY

Taplin, R., Kerr, R., & Brown, A. (2017). Monetary valuations of university course delivery: the case for face-to-face learning activities in accounting education. *Accounting Education, 26*(2), 144-165.

Weil, S., De Silva, T. A., & Ward, M. (2014). Blended Learning in accounting: a New Zealand case. *Meditari Accountancy Research*, *22*(2), 224-244.