A Relationship Study Of Student Satisfaction With Learning Online And Cognitive Load

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A RELATIONSHIP STUDY OF STUDENT SATISFACTION WITH LEARNING ONLINE AND COGNITIVE LOAD

by

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ABSTRACT

This study sought to explore if a relationship exists between cognitive load and student satisfaction with learning online. The study separates academic performance (a.k.a., "learning") from cognitive load and satisfaction to better distinguish influences on cognition (from cognitive load) and motivation (from satisfaction). Considerations that remain critical to the field of instructional design, as they apply to learning online, were described and used to guide a review of the literature to find directions to fulfill the goal of this study. A survey was conducted and 1,401 students responded to an instrument that contained 24 items. Multiple analysis techniques found a positive, moderate, and significant ($p < .01$) correlation between cognitive load and satisfaction. Most importantly, the results found that approximately 25% of the variance in student satisfaction with learning online can be explained by cognitive load. New constructs emerged from a Principal Components Analysis that suggest a refined view of student perspectives and potential improvement to guide instructional design. Further, a correlation, even a moderate one, has not previously been found between cognitive load and satisfaction. The significance of this finding presents new opportunities to study and improve online instruction. Multiple opportunities for future research are briefly discussed and guidelines for developing online course designs using interpretations of the emerged factors are made.

This work is partially dedicated to my parents. My father, Robert, and my mother, Jeanne, have probably been waiting years for me to finally do something like this, and their support has been wonderful. My mother instilled and nurtured a love for reading, and my father, analytical thinking and science.

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CHAPTER ONE: INTRODUCTION

The purpose of this study is to examine the relationship between cognitive load, as an indicator to the mental work of learning, and student satisfaction with asynchronous, online course work. Within the literature on cognitive load and instructional design, calls for additional research on the relationship of the affective domain with cognitive load are considerable. The proposed outcomes of this study are to (a) produce an instrument for measuring satisfaction and cognitive load, and (b) analyze the relationship between satisfaction and cognitive load.

The problem is that our current understanding of the relationship between motivation and learning remains tenuous and incomplete. As a human characteristic, motivation is both complex and unstable, thereby making the establishment of a useful theory of motivation difficult (Keller, 2006). Furthermore, current research efforts on cognitive load theory have not yet explored whether overload from multimedia delivery strategies have any effect on satisfaction. Adding to the problem is the potential for designers or instructors to employ multimedia instructional technology with negative consequences that could "…damage learning and discourage learners" (Clark, 1999, p. 28). Extending our understanding of how multimedia strategies affect human motivation may improve our ability to predict dissatisfaction or potential failure to achieve desired learning outcomes, and improve our employment of multimedia, as well as techniques commonly used in designing asynchronous, online learning programs.

Contextual Orientation to the Problem

Researchers studying cognitive load and multimedia-based learning note the lack of work being done to study the role of motivation and its impact on cognitive load and learning

(Astleitner & Wiesner, 2004; Low & Jin, 2009; Zheng, 2009). Keller (2006) suggests that recent advances in our understanding of how to systematically design motivation into instruction is benefiting students who *want to learn* but does not serve students who *do not want to learn*. For those unmotivated to learn, Keller calls for research emphasizing the learner in technology-based instructional environments (Keller, 1996; Keller, 2006). In a more recent article, Keller (2008) reinforces the need for continued inquiry on "…ways to systematically diagnose and develop solutions for motivational and volitional problems and to develop more refined and sophisticated approaches to the various types of e^3-learning" (p. 183). (Keller's conceptualization of "e^3-learning" reflects the increasing variety of distance teaching and learning delivery models, such as hybrid, online, and mobile, as these models must emphasize effectiveness, efficiency, and engagement.) He attributes the need partly to the complexity of motivation and partly to the increasing complexity of instructional delivery systems that he refers to as "e^3-learning." Within Keller's principles of motivation to learn, satisfaction is the fourth principle and differs from the other three in that the principle describes a targeted *outcome of* learning rather than a *condition for* learning. The difference between learning outcomes and learning conditions encapsulates the unique role satisfaction plays in designing for effective instruction: satisfaction, as a measurement, might provide insights into the effectiveness of the instructional design, provided we more fully understand the relationship it might have with cognitive load.

The question of a relationship between the reaction to instruction and learning flows over from practices in education into business training. The prevalent model for evaluating instruction is Kirkpatrick's four level framework (Kirkpatrick, 1959a; Kirkpatrick, 1959b; Kirkpatrick, 1960a; Kirkpatrick, 1960b; Kirkpatrick, 1998; Kirkpatrick & Kirkpatrick, 2005). In an article reporting the results of a meta-analysis of the relations among training evaluation criteria (i.e., the levels) and a book chapter on the same topic, Alliger and his colleagues (Alliger & Janak, 1994; Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997) find that reaction measures (i.e., level 1 in the Kirkpatrick framework) "…cannot be used as surrogates of other measures. In particular, affective reactions are unrelated to other indicators – liking does not equate to learning or performing" (p. 353). Later in the same article, these researchers concede the limitation to their meta-analysis stems from "several shortcomings" of Kirkpatrick's model that do not include "…recent developments from areas like cognitive psychology…" (p. 354). The researchers then identify the value of future research that explores "new taxonomic models" and "…alternative methods of gathering reaction data" (p. 354). This researcher interprets this as further indication for the need to explore the relationship between reaction to training (i.e., satisfaction) and learning.

Low and Jin (2009) recently offered the following observation regarding research efforts on cognitive effects from the use of multimedia within instructional contexts: "In the field of multimedia learning, research on cognitive effects and their implications for instructional design is rich. Given the importance of motivation in learning and the extensive use of multimedia learning in educational contexts, research on the effects of motivation in a multimedia learning context is surprisingly sparse" (p. 165). Indeed, their chapter appears as one of two on the topic of affective perspectives in multimedia learning in a collection of 18 chapters in the book, *Cognitive Effects of Multimedia Learning* (Zheng, 2009).

Instructional strategies that employ multimedia are exciting (i.e., attention-grabbing) but also potentially damaging if not carefully employed (Clark, 1999). Opportunities to include the wide variety of rich media increase the complexity of reaching effective instructional designs. Not only are there choices with media format, but there are choices to determine the level of interactivity between the system and learners, between the learners, between the instructor and learners, and between learners and outside resources (i.e., both organic and inorganic). Within each of those interactions, Clark (1999) would include access, pacing, scheduling, feedback, and structure amongst the options a designer or instructor will have to make when building the instruction. To reduce potential damaging consequences and improve the positive potential of instruction using multimedia, he suggests monitoring two motivational indexes (Pintrich & Schunk, 1996): mental effort and persistence. Clark notes that mental effort, or "…the amount of energy invested in the conscious, deliberate and cognitive elaborative processing required to learn novel declarative knowledge…" (p. 28), is correlated to cognitive load and task-specific efficacy. This is a further indication of the importance in studying the relationship between cognitive load and satisfaction for instances that leverage multimedia technologies. However, in the work by the authors of the two articles (Clark, 1999; Low & Jin, 2009), their references to multimedia technologies do not specifically include asynchronous, online learning.

The preceding discussion clearly presents the need to study whether a relationship exists between cognitive load and student satisfaction. The bridge between the specific calls for additional research on the relationship between satisfaction (i.e., the affective domain) and cognitive load, as pertains to multimedia-based learning, can and should be extended to include asynchronous, online learning. The argument for this position is that the instructional elements that comprise the set of instructional materials or devices used within online asynchronous courses are vast and varied – and they often are the same multimedia technologies to which Low and Jin and Clark refer. Today, instructors routinely use and mix text, audio, video, animation, and simulations in their strategies to teach asynchronous, online courses. It is this broad employment of a variety of technologies that instructors can use within online course delivery that suggests extending the call for additional research on satisfaction and cognitive load to include online learning contexts.

As previously discussed, there is considerable support for additional research on the relationship of satisfaction (i.e., the affective domain) with cognitive load as it pertains to multimedia-based learning. In this study, the need to conduct further studies on multimedia learning is extended to include asynchronous, online learning, which can be called "asynchronous learning networks," or ALNs. An operational definition of ALN is provided later in the operational definitions section.

The proposed outcome of this study is to produce an instrument for measuring and methods for analyzing if a relationship exists between satisfaction and cognitive load. Such outcomes will be useful for instructors and instructional designers whose responsibility it is to design and deliver quality instruction using asynchronous, online delivery strategies.

The Problem Statement and Applicable Theoretical Basis

As noted earlier, the primary problem under study is the relationship between human motivation and learning remains unclear. Specifically, this study will seek to answer the question: is there a relationship between cognitive load theory and student satisfaction with asynchronous, online course work? The study intends to answer the question and address the problem by testing the hypothesis through data collection and a quantitative analysis. An instrument will be created and validated to support data collection. The instrument will be delivered to students electronically using the Internet. The findings can be used to provide formative information for instructors and instructional designers who build and support asynchronous, online courses.

Research involving satisfaction is tied to the field of motivation. For decades researchers separated motivation and cognition in their studies (Volet, 2001a). There are reasonable explanations why satisfaction studies do not include aspects of information processing theory, such as cognitive load. Research on satisfaction seems to have been conducted by those preoccupied with motivation and not by those studying cognition – the research groupings were separated philosophically. However by the late 1990s, a growing trend among educational psychologists included studies of cognitive development emphasizing the social nature of learning (De Corte, 2000; Järvelä, 2001). In 1986, Sorrentino and Higgins took the view that future research must consider cognition and motivation as inseparable (Sorrentino & Higgins, 1986).

The learning process usually takes students from novice levels to more highly informed or skilled levels – not necessarily mastery, but towards mastery. According to dual-process theories of cognition, information processing takes place simultaneously on parallel pathways. On the controlled pathway, processing is effortful, slow, and conscious of perceptual and semantic information. On the automatic pathway, processing is effortless, fast, and non-conscious through pattern recognition-based processes that are said to rely on heuristics and generalized, stereotypic schematic representations (Feldon, 2007b; Schneider & Shiffrin, 1977; Sloman, 2002). This bears a strong relationship to the automaticity construct in foreign language learning. Processing through the controlled pathway is restricted to the constraints of working memory (Cowan, 2001; Miller, 1956, 1994) and excessive cognitive load can "…prevent fully conscious, deliberate reasoning by forcing some goals to be… neglected" (Feldon, 2007a, p. 124). This theoretical framework is part of Cognitive Load Theory (CLT). Aspects of CLT suggest mechanisms, such as split attention, redundancy, the modality effect, or extraneous load, by which the novice learner can become overwhelmed and successful learning becomes unlikely. Students may not be aware of these effects, but their satisfaction with learning in an excessively loaded climate may reflect a negative experience without the students necessarily knowing the source of their dissatisfaction. Research in CLT suggests using instructional design techniques to mitigate cognitive load related issues for students (Clark, 1999; Deubel, 2003; Hartley, 1999), while not at all addressing the affective domain because the focus in those studies did not take into account whether a relationship exists between these cognitive load experiences and student satisfaction. The case being made here is that research on student satisfaction should include aspects that incorporate cognitive load, which is part of the learning experience. To support this research, the theoretical orientation for cognitive load theory includes the following works: Brünken, Plass, & Leutner, 2003; Mayer, & Moreno, 2003; van Merriënboer, Jeroen, Kirschner, & Kester, 2003; and Pass, Renkl, & Sweller, 2003b.

In their article *Nine Ways to Reduce Cognitive Load in Multimedia Learning*, Mayer and Moreno (2003) examine five overload scenarios identified from 12 years of empirical research that included 30 experiments. For each of the five scenarios, the authors describe the cognitive processing problem details, along with proposed methods to reduce the load. For this study, the work by Mayer and Moreno will provide a framework from which survey items can be developed as a means to indicate evidence of overload instances within asynchronous, online course work. The details for selecting and implementing this strategy are discussed in more detail in the methods section in this chapter, as well as in the review of the literature and methods chapters.

Hypothesis

A null hypothesis will be tested to answer the research question. Null hypothesis (H_0): there is no relationship between perceived cognitive load (as described by Brünken, Plass, & Leutner, 2003; Mayer, & Moreno, 2003; van Merriënboer, Jeroen, Kirschner, & Kester, 2003; and Pass, Renkl, & Sweller, 2003b) and satisfaction with their online learning experience.

Operational Definitions

Asynchronous Learning Networks (ALNs): Distributed instructional delivery systems whereby the preponderance of activity between students and instructor is asynchronous, which are Web-only (W) and Mixed-mode (M) type courses (Dziuban, Moskal, Brophy-Ellison, & Shea, 2007).

Cognitive Load Theory: Cognitive load can be said to be the non-automatic mental elaborations applied to information processing or learning. The theory seeks to clarify the cognitive processing differences between novices and experts (Feldon, 2007a; Paas, Renkl, & Sweller, 2003a, 2003b; Sweller, 1988; Salomon, 1984). The theoretical framework includes a categorization of three types of cognitive load: representational holding (i.e., intrinsic), incidental (i.e., extraneous), and essential (i.e., germane) (Mayer and Moreno, 2003; Pass, Renkl, and Sweller, 2003a). The details behind the duplication of terms are elaborated in the following section. Deriving student perceptions for each of the three categories define their cognitive load for a course.

Satisfaction: Satisfaction refers to a range of feelings, from positive to negative, about a learner's accomplishments and learning experiences. These feelings are intrinsic in the individual learner, are associated with an outcome that is perceived by the individual to be fair, and are influenced by extrinsic rewards (i.e., the situative learning context) (Dubuc, 2009; Deci, 1975). Overall student satisfaction is derived from self-report items.

Proposed Method

The methods for this study will involve two phases: instrument development and analysis of the final data set. The research study seeks to examine the relationship between cognitive load and satisfaction, which represents a new direction in the field of cognitive load theory and motivation theory research. There are several indirect measurement instruments designed to work with cognitive load, but these instruments – Subjective Workload Assessment Technique (SWAT), NASA Task Load Index (TLX), and the Workload Profile (WP) (Rubio, Díaz, Martín, & Puente, 2004) – are task focused, and they are not designed to incorporate satisfaction. Therefore, to meet the needs for this study, a new instrument will be developed and piloted. The development efforts reflect phase 1 activities. The final instrument will be the outcome of phase 1. Phase 2 activities will include analysis of the data collected using quantitative techniques. The outcome of phase 2 will be the reported findings.

Phase 1. Instrument Development

To derive the satisfaction data, the study method will employ data collection and quantitative analysis. Data collection will use a questionnaire delivered online and will include response items developed following guidelines on cognitive load theory, student satisfaction with learning via ALNs, and student demographics. The dependent variables associated with this research study are student perceptions of cognitive load and their perception of satisfaction to achieve course objectives. As discussed previously, the work by Mayer and Moreno (2003) will be leveraged to develop the items for the cognitive load items for the electronic questionnaire. The Sloan Model (Dziuban, Moskal, Brophy-Ellison, & Shea, 2007; Moskal, Dziuban, &

Hartman, 2009) will be leveraged to develop the items for the student satisfaction with learning via ALNs. The complete instrument is fully presented in Chapter 3 - Methods. Items for cognitive load and satisfaction statements will be set in a five-point Likert rating scale to range from *Strongly Agree* to *Strongly Disagree*. The midpoint will be *Neither Agree Nor Disagree*. Open-ended items will also be used for participant free response.

Study participants will be current college students who state they have had experience with asynchronous, online courses prior to the term the study is conducted, who are 18 years of age or older, and who agree to participate in the study. They will be recruited from current online course offerings that are offered as either type W (fully online) or M (mixed mode or blended) courses. Working closely with Course Development & Web Services and the Center for Distributed Learning, instructors of type W or M courses will be approached to participate in the study. The only effort on the part of participating faculty will be to permit solicitation of student participation through the Webcourses@UCF infrastructure. This researcher will develop a solicitation message that will be delivered through Webcourses@UCF. The message will include a link to an instrument that exists on an independent server. The survey environment that contains the instrument will provide multiple accesses, while guaranteeing participant anonymity. Further, the survey environment supports export to statistical analysis packages.

Dillman (2006) recognizes instrument pretesting as a "…highly touted part of questionnaire design" (p. 140) and divides this process into the following four sequential stages: (a) review by knowledgeable colleagues; (b) interviews to evaluate cognitive and motivational qualities; (c) conducting a small pilot study; and (d) doing a final check.

These are the steps this researcher will take to fulfill Dillman's four step process. Following a review by recognized experts in the design and operationalization of survey instruments, the instrument will be pilot tested with an appropriate sample of online students. Not only will they be asked to respond to the instrument, but they will be asked to provide feedback and reflection about the instrument's ease of response and to react to particular items that may have been problematic for them with suggestions for improvement. The item's responses from the pilot study will be subjected to analysis and development procedures for the satisfaction and cognitive load subscales separately.

Data analysis will include a variety of quantitative analysis techniques: (a) response distributions; (b) alpha reliability coefficients and the impact when items are removed; (c) correlation of satisfaction and cognitive load total scores; and (d) the covariance of the component subscales.

Phase 2. Analysis of the Final Data Set

The final instrument will be administered to a sample of approximately 1000 students enrolled in online classes. Once the final study data have been obtained, the following analysis procedures will be completed: (a) response distributions; (b) alpha reliability coefficients and the impact when items are removed; (c) correlation of satisfaction and cognitive load total scores; (d) the covariance of the component subscales; (e) factor analysis of the instrument using the Principal Component and Image Analysis procedures; (f) analysis of the satisfaction and cognitive load total subscale scores by the categories of the demographic student variables through the application of ad hoc hypothesis testing procedures; and (g) the regressions of cognitive load on satisfaction, and satisfaction on cognitive load.

Study Limitations

There are five non-trivial limitations to this study. The first is access to students: this study is dependent upon relationships with faculty members and the permission to incorporate the instruments into their courses. The second is the representative nature of the student sample: the student population sample will be drawn only from UCF, which means this may or may not be representative of college students across the United States. The third limitation originates from the assumption that the courses being surveyed are not so well designed as to be free from all aspects of cognitive load, and thereby permitting students to perceive none. The fourth limitation is the instrument to study the relationship. Since studying student satisfaction and cognitive load within an online context is new, any findings may be influenced by the instrument. Later studies may seek to validate the instrument to remove this limitation. The fifth limitation involves the risk associated with electronic survey samples: response rates are known to be poor for online surveys, and while every strategy possible will be leveraged to improve responsiveness, it represents a well known risk.

Significance and Implications

This research study explores the relationship between constructs of motivation and cognition. Studying this relationship strengthens the field of instructional technology, where the emphasis is in the pragmatic. Student engagement in learning, persistence to conclusion, predictable learning outcomes and academic achievement are just a few of the pragmatic targets the field serves. To date, past research has given the field two claims of concept with which this study is directly concerned: (a) cognitive load influences student engagement, performance, or achievement; and (b) satisfaction influences student persistence or motivation. From these two claims, the question whether cognitive load can be perceived as a motivator (or the opposite condition – whether the load can be perceived as an un-motivator) is a logical extension of research to date, while retaining the pragmatic requirements to better explain learner behavior and predict functional outcomes that will guide instructional design.

In a recent research study, Capan, Lambert, and Kalyuga (2009) commented on the ambiguous nature of the relationship between mental effort and actual cognitive load and speculated that a "…low mental effort could be the result of low cognitive load or simply a lack of interest or engagement in activity" (p. 156). Among their findings, the researchers noted that "…students placed greater values on more challenging topics or activities…" (p. 160). However, this cannot be taken at face value as Paas, Tuovinen, van Merrienboer, and Darabi (2005) previously noted that if "…learners perceive a learning task as too easy or too difficult they may not be willing to invest mental effort in it and cease to learn" (p. 32). The focusing thread is that cognitive load by itself does not seem able to predict performance or achievement without including motivation as a variable. This idea is furthered by Colquitt, LePine, & Noe (2000) with their finding that a "… 'g-centric' approach to trainability is insufficient, given the strong effects of motivational variables over and above cognitive ability" (p. 702).

Motivation would seem to play a significant role in studies on cognitive load. Some researchers studying mental effort or cognition use motivation to explain differences in outcomes (Kanfer & Ackerman, 1989; Paas et al., 2005; Salomon, 1983; Tuckman, 2003). In other studies, researchers differentiated learner orientations to explain differences in satisfaction reactions (Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000), which partly led Paas et al. to state that the "…perspective regarding the relation between mental effort and performance is based on the assumption that motivation, mental effort and performance are positively related" (p. 28). This last is a large assumption and represents one strong argument for this study by exploring whether such an assumption has warrants. While this study will not include performance, learning more about a relationship between motivation and cognitive load could provide clarification to students' persistence to learn (or lack thereof) and an indication of engagement.

For the field of instructional technology, this study contributes to the growing discussion on cognitive load by essentially exploring the influence of motivation to persist when learning is difficult or complex. Coupling satisfaction to cognitive load can provide additional guidelines on effective instructional design, while providing deeper insight to the relationship between motivation and cognition.

The findings will also benefit multiple local constituencies: students who enroll in online courses (especially those who enroll almost exclusively in online courses or academic programs of study), faculty who teach and develop online courses, department chairs and college deans who support online teaching and learning initiatives, and university support services for online teaching and learning. The findings can also be used to favorably adjust elements of an online course.

Further, the findings can be used to improve approaches for measuring student satisfaction. This study makes two assumptions about student satisfaction. The first assumption is that satisfaction is intrinsically determined; however it is influenced by extraneous, situative factors from the learning context. Factors that influence satisfaction can remain obscured. This study seeks to reveal additional factors that figure into the satisfaction experience. The second assumption is that cognitive load theory can be used to study the intrinsic factors associated with the mental work of learning, which allows researchers to separate this type of influence from other variables originating from the larger field of learning context.

It is appropriate and timely to express the rationale of this study as it serves the field of instructional design. As illustrated in figure 1 below, we see a high-level conceptualization of a researcher's perspective of the process of instructional design where multimedia or asynchronous-based learning scenarios are considered and developed.

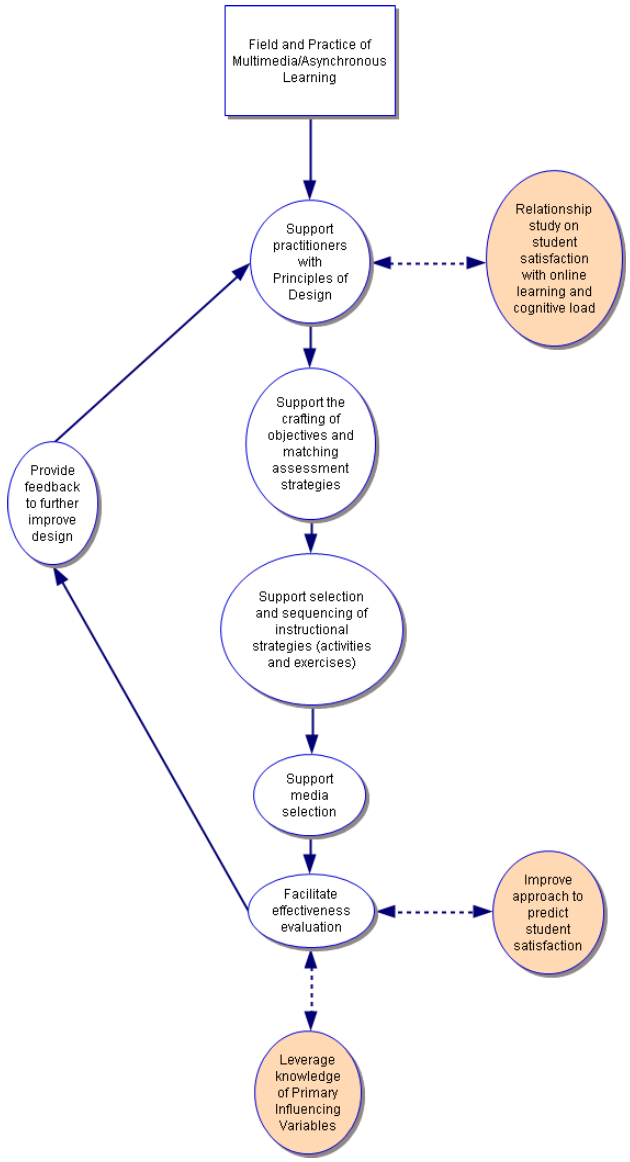

Figure 1. A researcher's perspective of this study's support to the systematic design process of multimedia-based and asynchronous-based learning.

Figure 1 depicts the field and practice being guided by research focused on supporting practitioners. Research guides design through the development of Principles, supports the crafting of objectives and matching assessment strategies, supports the selection and sequencing of instructional strategies, improves the choice and design of activities and exercises, and facilitates the evaluation of the design as to how effective the result is to achieving goals or objectives. Fitting into this process, the rationale for this study is that a more clear understanding of the potential influences cognitive load might have on student satisfaction with online learning will support the field and practice of instructional design and the eventual development of principles. Further, the results of this study may improve the approach to predict student satisfaction. This improved ability to predict satisfaction would support evaluation efforts to determine the effectiveness of the design solution. An improvement in an effectiveness evaluation becomes possible by being able to recognize the variables with the largest effect on satisfaction and noting the nature of those variables' influence. Such influences on the effectiveness of the instructional solution would in turn provide strengthened feedback in a loop to improve the design process. So stated, this rationale sets the boundaries and direction for the study to address the problem, as well as directing the review of the literature in the next chapter.

Chapter Summary

Summary

This study proposes to research the possibility that cognitive load theory can be used to learn more about student satisfaction. The investigator proposes using theories on cognitive load to develop lines of inquiry to be integrated into a student satisfaction questionnaire. The instrument will be delivered electronically to students participating in or having had participated previously in asynchronous, online courses at UCF. The research method is broadly outlined, the limitations the study faces are presented to clarify the potential benefits and challenges, the significance of the study is considered, and the rationale that briefly discusses the fit of the study into the field of practice of instructional design concludes this chapter.

Bridge to Next Chapter

The next chapter is the review of the literature. In chapter 2, the targets for the review of the literature include restating the problem, restating and clarifying the purpose of the study as it seeks to address the problem, stating the objectives of the review, and providing an overview of the chapter and the process followed to create the chapter structure.

Chapter 2 also presents a discussion of instructional design concerns with online learning that align with the problem statement, relevant research in motivation, relevant research in cognition, and connecting student satisfaction with cognitive load. The topic organization and discussion lead the reader with logic and synthesis to identify the design attributes necessary to fulfill the study purpose.

CHAPTER TWO: LITERATURE REVIEW

In the introductory chapter, the rationale of this study illustrates a flow of directed activities to guide practitioners' efforts to produce instructional designs (see figure 1). If through this study a relationship was found between cognitive load and student satisfaction, then practitioners would have an additional resource to improve the effectiveness of instructional solutions. Having some ability to improve predictions of student satisfaction implies deep knowledge of the relationship between learning and motivation. This knowledge enhances interpretation of solution effectiveness, which also functions as part of a feedback loop to improve guiding the instructional design process. The flowchart indicates where this study serves the field of instructional design, when the design implements multimedia or asynchronous learning strategies.

The introductory chapter contains several claims. The key claims might be summarized as the following:

- Current research efforts on cognitive load theory have not yet explored whether overload from multimedia or asynchronous delivery strategies have any effect on student satisfaction.
- Research in Cognitive Load Theory suggests using instructional design techniques to mitigate cognitive load related issues for students (Clark, 1999; Deubel, 2003; Hartley, 1999), while not addressing the affective domain because the focus in those studies do not take into account whether a relationship exists between cognitive load experiences and student satisfaction.

- However, we read "…that motivation, mental effort and performance are positively related" (Paas et al., 2005).

The differences in these claims underline the need addressed by the study rationale: the field of instructional design requires a more clear understanding of the potential influences cognitive load has upon student satisfaction with learning solutions that employ multimedia or ALNs (i.e., asynchronous learning networks; a.k.a., "asynchronous online learning," or "online learning"). In the absence of a more clear understanding of the relationship between motivation and cognitive load, practitioners will continue to strategize speculatively. The rationale for the study and the consideration of these claims guide this review of the literature.

Targets for this Review of the Literature

Conceptualization for Study and Organization of the Review

Figure 2 provides a conceptual representation of the problem with a theoretical framework that guides this study. Within the context of online coursework, students internally process motivation or cognitive elements associated with the learning environment. Satisfaction, as a component of motivation, has historically been associated with the context of the learning environment, and students (a.k.a., learners, trainees, etc.) are often evaluated on their *reactions* to those components. In this study, Deci's (1975) Cognitive Approach of Motivation is referenced to focus Keller's meta-theory that produced the ARCS Model on satisfaction, and leverage the theoretical relationship satisfaction has with purposive behavior. Examining the learning context of online environments, this study will leverage the Sloan Model developed by Dziuban et al. (2007) by using the constructs that influence student satisfaction with online learning to separate context as a separate variable. The cognitive approach of motivation and the context of online learning represent satisfaction in this study.

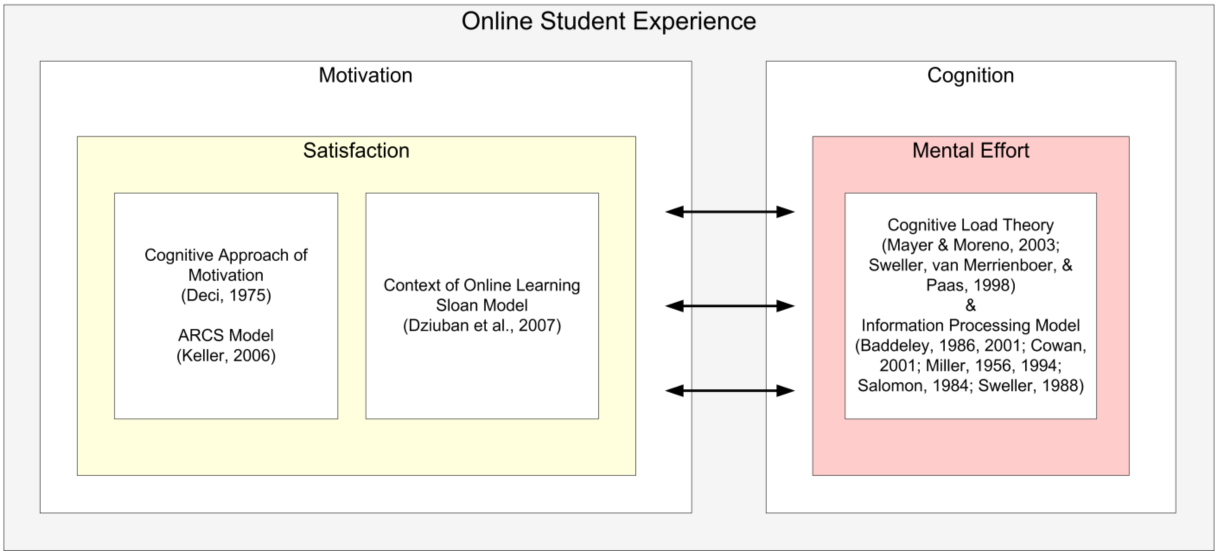

Figure 2. Conceptual framework illustrating the relationship between major variables under study and key theoretical and empirical foundations.

Instructional design is an applied field, and research in this field should always have this focus. Practitioners leverage multiple theories, tools, and expert experiences to guide the development of instructional designs. Because the field of instructional design is complex, there are always concerns regarding practice. Among the concerns are (a) the selection of media selection and delivery channels, (b) the alignment of design with learning and motivation principles, and (c) the evaluation of achievement or performance. All systematic approaches to designing and developing instruction target these three areas, although not always in the same manner. These concerns are as important as they are vast to a designer or instructor, and research should avail itself to address such concerns. Towards that end, this study uses these concerns to guide the overall structure of the review.

The primary topic areas to be addressed in this review are (a) the instructional design concerns with online learning strategies; (b) relevant research in motivation; (c) relevant research in cognition; and (d) connecting student satisfaction with online learning to cognitive load. Each of these four topic areas is further sub-divided to support the investigation of evidence, warrants, or backing to the claims identified in the chapter introduction.

The review of the literature is divided into five major sections: (a) targets for this review of the literature; (b) instructional design concerns with learning online; (c) relevant research in motivation; (d) relevant research in cognition; and (e) connecting satisfaction to cognitive load.

The first section, *targets for this review*, is further divided into five subsections: (a) conceptualization for study and organization of the review; (b) objectives of this review of the literature; (c) quality in conducting a review of the literature; (d) problem elaborated; and (e) restating the purpose.

The second section, *instructional design concerns*, is further divided into four subsections: (a) evaluating achievement or performance; (b) selecting multimedia, internet-channels - the complexity of options; (c) aligning design with learning and motivation principles; and (d) instructional design concerns with learning online: a summary.

The third section, *relevant research in motivation*, is divided into four subsections: (a) current trends in motivation research: context of learning; (b) theoretical foundations for studying student satisfaction; (c) research approaches to studying student satisfaction; and (d) the situative context of student satisfaction in ALNs.

The fourth section, *relevant research in cognition*, is divided into five subsections: (a) an overview of the information processing model: past and present; (b) dual processing theory: a brief discussion of expertise; (c) orientation to cognitive load theory; (d) cognitive load theory and instructional design: should load be avoided?; and (e) measuring cognitive load.

The fifth section, *connecting satisfaction to cognitive load*, is divided into two subsections: (a) cognitive load scenarios; and (b) satisfaction variables & cognitive load scenarios.

The review concludes with a chapter summary and a bridge to the next chapter.

Objectives of this Review of the Literature

A review of the literature should have and accomplish specific objectives (Boote & Beile, 2005). The following are Boote and Beile's (2005) objectives that any review of the literature should include:

- Set the study's broad context
- Define clearly the scope of the study and what is outside of that scope
- Justify decisions made on the scope of the study
- Situate existing literature in its broad context of scholarship and history
- Report claims made in the literature and critically examine whether the claims are warranted

And further, a review of the literature can be said to possess quality if the review reaches "…appropriate breadth and depth, rigour and consistency, clarity and brevity, and effective analysis and synthesis…" (Hart, 1998, p.1).

This review of the literature seeks to fulfill the stated objectives by taking the following actions:

- The broad context of this study is an investigation on a possible relationship between cognitive load and student satisfaction with coursework completed within ALNs. For this review, research work that does not serve this stated context will be excluded.
- The scope of this study is to accept or reject the null hypothesis: there is no relationship between perceived cognitive load and satisfaction with their (i.e.,

students') online learning experience. This review will not include discussions that are not relevant to the study purpose or scope.

- As previously discussed within this chapter and the introductory chapter, the scope of this study does not include the direction of the relationship or the inclusion of performance as a target variable. The argument for the decision to exclude these interesting research topics is that both represent questions that follow the initial question that guides this study. Topics such as these imply the existence of a relationship that has yet to be identified. For this review, relevant research efforts will be sought that facilitate the design of this study and will fit within the stated scope of this study.
- This review will situate the context of scholarship and history to appropriate research on motivation and cognitive load that fit within the stated scope of the study.
- This review will endeavor to report and critically examine whether stated claims are warranted for selected research that fit the stated study scope.
- This review will identify a theoretical framework to guide research efforts.

To meet Hart's conditions for quality in a review of the literature, the following section presents an overview of the review, which includes the constraints used to limit and control the scope, the results of a thoroughness and currency analysis to further focus and refine the review, and the structure of the review that coalesces from the preceding constraints and analyses. The purpose of documenting the steps that lead to material inclusion or exclusion is to force the focus of the review while retaining a general goal of quality.

Quality in Conducting a Review of the Literature

To focus the review of the literature to the stated scope of study, some constraints are required. Work published through peer-reviewed journals will be considered, while material published through non peer-reviewed journals will not, unless that material provides a critical point to the review and source is reliable. Priority for selection for review will be material published in the following list of journals:

- Journal of Educational Psychology
- Journal of Applied Psychology
- Educational Technology Research & Development
- Psychological Bulletin
- Psychological Reports
- Journal of Higher Education
- Journal of Counseling Psychology
- Review of Educational Research
- American Education Research Journal

In addition, material presented and published at conferences organized by the following associations will also be given consideration for inclusion:

- The American Educational Research Association (AERA)
- The American Psychological Association (APA)
- National Council on Measurement in Education (NCME)
- Association for Educational Communications and Technology (AECT)
- Annual Conference on Distance Teaching and Learning (University of Wisconsin, Madison)

Further, research that does not include a description of methods will be excluded, as will material written in languages other than English, French, or Swedish. A citations analysis that considers currency will be used. Regarding the currency criteria, acceptable material will be limited to published works within the last 15 years, unless the article is considered seminal. Other materials that will be considered include dissertations and conference papers. Conference papers must, however, be published through the above listed associations. Finally, a thoroughness analysis is used.

For the thoroughness analysis, Hjørland (1988) argues that a review of the literature in the social sciences should include eight mandatory viewpoints. Use of these viewpoints, or facets, can function as a litmus test to set boundaries of the literature review, while striving to ensure thoroughness across key areas. The full details of the analysis are presented in table 23, Appendix A, and list all the authors' used in this review. Each article is set within Hjørland's facets to present the balance, or lack of balance, of reviewed material relevant to this study. Hjørland's facets are the following: (a) research methods; (b) theoretical orientation; (c) time, place, and form; (d) psychological processes; (e) psychobiology; (f) individuals and personality; (g) social and cultural; and (h) sphere of application.

To fit into a usable table, the convention of noting only the first three leading authors, without initials, is provided with the publishing year and title of the publication. In this review, 120 publications are referenced, whereof 63 are journal articles, 49 of which are peer-reviewed, and 46 are books or book sections. Also, two research bulletins are referenced, along with three conference papers, four reports, and two websites. The final single item is an unpublished manuscript; however that document originated from a co-chair of the committee overseeing this dissertation, and the item is a manuscript of a workshop delivered to university faculty on key topic. Regarding currency of materials used in this review of the literature, 24 citations are five years or less old; 31 are between five years and equal to or less than 10 years; 13 are between 10 and equal to or less than 15 years; 13 are between 15 and equal to or less than 20 years; and 39 are older than 20 years. The large number of older materials is somewhat misleading as most reflect support to current materials.

Searching for relevant material can lead to distracting content or imbalances in an important category that might be critical in a research study. Using Hjørland's facet approach, content was vetted iteratively, which resulted in some facet areas growing, being pruned, or extra effort being made to fill gaps. This effort also strengthens the structure of the literature review as patterns of topic areas necessary to support the research purpose became apparent. The emergence of topic areas, or subcategories, was used to define the outline of this review.

In the introduction of this chapter, three claims are presented that succinctly reflect the nature of the problem. Later in the problem and purpose of the study re-statement sections, the logic of the study is presented and argued. Applying an argumentation analysis, such as Toulmin (see Hart, 1998), to the claims, the problem, and the purpose of the study, what emerges is that review of the literature requires evidence (or data to support the claims), warrants (or the expectation that provides linkage between evidence and claim), and backing (or the context and assumptions to support warrant or evidence validity). Some evidence, warrants, and backing are provided in chapter 1 to support the claims (e.g., direct quotes from authors, cited work indicating areas of research that are weak or missing in the body of literature, etc.). The full purpose of this chapter is to elaborate the evidence, warrants, and backing in a way that thoroughly analyzes and synthesizes relevant work by experts.

Problem Elaborated

Mental effort (as a component of cognition) is studied for a possible relationship with satisfaction (as a component of motivation). Cognitive Load Theory and the Information Processing model will be leveraged to explore mental effort. Contributions to Cognitive Load Theory by Mayer and Moreno (2003) and by Sweller, van Merrienboer, and Paas (1998) provide the constructs to study mental effort. The relationship being studied has two primary variables: satisfaction and mental effort. Identifying scales to represent satisfaction and mental effort is a partial objective of this review of the literature. The remaining objective is to thoroughly explore the topics that permit convergence of mental effort with satisfaction, and how studies have been conducted for studying these constructs.

The problem to be studied arises simply because the relationship between motivation and learning remains unclear. Regarding one of these elements, motivation, Keller (2006) continues to describe the nature of motivation as *unstable* and the establishment of a useful theory as *difficult*. Regarding the other element, learning, we can start this discussion by considering Clark's (1999) definition of mental effort as "…the amount of energy invested in the conscious, deliberate and cognitive elaborative processing required to learn novel declarative knowledge…" (p. 28). Now by using a simple transformation, we might suggest that a positive investment of mental effort coupled with positive performance outcomes should indicate the occurrence of learning. From the perspective of this transformation, *learning* is indicated by performance and is separated from *mental effort*. Since *mental effort* is a component of *cognition*, in this study the transformation perspective places cognition as separate from learning: cognition is the processing of mental effort, and learning is a desired result of the processing. Learning is usually indicated by evidence from an evaluation. Thus, learning, being indicated from an evaluation, stems from some interplay between motivation and cognition. This interplay is ambiguous, while also playing a critical role in the promotion of learning. Thus, we narrow the focus to the ambiguous relationship between motivation and cognition.

In contrast to recognizing the tenuous nature of the relationship between motivation and cognition, several leading researchers express unproven relationships. Paas et al. (2005) assert that motivation, mental effort, and performance are positively related. Clark (1999) asserts that mental effort is correlated to cognitive load and task-specific efficacy. Clark's assertion builds from an earlier insight by Salomon (1983) who studied the relationship between mental effort and the differential perceptions of the media used to convey learning. Because Salomon's findings unexpectedly showed that differential perceptions of media did not correlate with learning, Clark seems to realize the interplay of other variables, such as efficacy. These represent just a few of the many variables used in studies on motivation and learning.

Some of these variables would seem to be subcomponents to either motivation or cognition, but researchers tend to not categorize them as such. Clark's formulation (1999) includes task-specific efficacy with cognitive load to *describe* and quite possibly *predict* mental effort and persistence. Task efficacy might be considered the scaffold, or represent the schema, that supports effortless processing, which will influence mental effort. Salomon's research formulations (1983, 1984) include cultural notions that influence perception, which were presumed to influence mental effort. Different from Salomon's perspective of mental effort and the influence of culture and media, Abrahamson (1998) notes that media used in distance education can be a motivator. Schemata can also function as motivators, as they function to inform the learner that the job of learning can potentially require more mental effort (i.e., be more *effortful*) or less mental effort (i.e., be more *effortless*). While efficacy and cultural predilections must certainly figure into the process of learning, perhaps they are a subcomponent of motivation that have an influence on the level of mental effort a learner is willing to invest to learn.

Cognitive Load Theory seeks to make sense of the relationships between motivation and learning, and its foundations include the information processing model and extensive empirical science. Cognitive Load Theory presents a collection of principles to guide instructional designers with strategies that account for the limits and possibilities associated with mental effort to improve the likelihood that learning occurs. If mental effort can be described and predicted from principles that form the body of Cognitive Load Theory, then it becomes necessary to explore the motivational connection that might exist within aspects of cognitive load. This is a similar problem Salomon (1983, 1984) explored, and to which Clark (1999) alludes: we must be mindful of media selection and use so as to prevent the possibility of damaged learning and discouraged learners. Using media as an instructional strategy, while it might have a motivational function or appeal, the media also contributes to cognitive load. But research does not tell us whether this cognitive load is also functioning as a motivator, or its opposite, an un-motivator. The cognitive load experienced by implementing a variety of media strategies in an ALN might motivate some learners to persist and invest in the mental effort to learn, or it might have the opposite result.

This discussion of motivators in a given ALN applied to the learning environment of an entire course assumes the existence of a broad range of actors. Some motivators play major roles, such as a particular course is required for graduation. Other motivators might play smaller roles, while still being significant in the immediacy of success within a critical part of a course, such as mastering the Pythagorean Theorem in a geometry course. Achievement of learning might be facilitated or hindered depending upon that smaller motivator and its influence on the learner's investment of mental effort. For example, if an animated Adobe Flash component is designed and used to convey a physics principle, the visual and dynamic nature of that component used in conjunction with static equations and conceptual explanations might result in a reduced cognitive load as the learner does not need to generate the visual animation within imagination.

A variant of such an example might instead increase the cognitive load and thereby also increase the necessary investment of mental effort to succeed with learning. In this situation, the question becomes whether a particular learner will be motivated with the learning challenge or not. An example of such a situation might be for the same physics principle, where the component is instead programmed with the physics' principle improperly applied, and the learner must learn to identify the principle that is wrongly employed. In either situation, a learner might or might not be successful learning the physics principle. But one learner might find the cognitive load created by the strategy selection as a motivator, whereas another might find the load as an un-motivator.

Consider the possibility that an instructor or instructional designer consistently employs one over the other of these two strategies throughout the course. It would be reasonable to assume that amongst the learners taking such a course, some might find the cognitive load greater than others do. For those willing to invest in the mental effort to succeed with learning, the cognitive load associated with the instructional strategy might be said to function as a motivator. For the others who are unwilling to invest in the necessary mental effort, the cognitive load might be said to function as an un-motivator. Task or topic efficacy and other variables may play a role on a learner's perspective with this situation, but equally possible there can be occasions when variables such as task or topic efficacy are less important than the discussed motivational element that might also exist.

The problem stated from this perspective accentuates the question whether a relationship exists between motivation, mental effort, and performance. This relationship is the assumed, and missing, connection between motivation and learning. This research study intends to investigate part of this relationship – that between motivation and cognition – while excluding at this time performance, which one might term *learning*. Performance (or learning) is not being addressed since its inclusion would imply we understand the relationship between motivation and cognition better than we currently do.

In this study, cognition will be considered a result of invested mental effort into the cognitive load created by the instructional strategies employed with a given online (i.e., ALN) course. With this perspective, cognitive load functions as an indicator of mental effort perceived by the student (a.k.a., "learner" – in this chapter, the two terms, learner and student, are used interchangeably). And, as will be considered in greater detail later in this chapter, *satisfaction* with the perceived cognitive load functions as an indicator of positive or negative motivation.

Restating the Purpose

In the most general sense, this study explores the possible relationship between motivation and cognition. To more narrowly define the purpose of this study, the general scope is to focus on whether student satisfaction with online learning (i.e., ALNs) is influenced by cognitive load. From the discussion in the previous section, recognition or acknowledgement that cognitive load exists in an online course reflects the likelihood that some level of mental effort is required to learn, and a learner's satisfaction expressed on that recognition or acknowledgement reflects a motivational subcomponent to cognitive load. Part of the purpose of this study is to devise a means to permit the recognition or acknowledgement of cognitive load, present an opportunity to reflect on satisfaction with such situations, and present the context of ALN learning satisfaction. Another part of the study is to capture demographic information and use this data to explore the possibility of other relationships with satisfaction and cognitive load.

The purpose of this study does not include seeking the direction of any explored relationships. Effort spent on whether a relationship is either positive or negative might follow in subsequent research, but such effort lies beyond the scope of this study and therefore is not part of the purpose. The purpose is to prove or disprove the null hypothesis stated in the previous chapter, which only includes whether a relationship exists between perceived cognitive load and satisfaction with a students' online learning experience.

Instructional Design Concerns with Learning Online

As a field of practice, instructional design is the systematic application of procedures followed to produce quality education and training programs that are consistent and reliable (Gustafson & Branch, 2002). The field is concerned with producing consistent results as education is delivered through any channel, whether that channel is print, audio, video, lecture, local technology-based (i.e., on your computer), remote technology-based (i.e., on another computer connected by networking), or any combination of these. This study focuses on learning that takes place when students access educational programs through asynchronous learning networks (ALNs). ALNs present a very wide range of choices for media that might be used, which represent complex choices for instructors or instructional designers. The critical characteristics that differentiate instruction designed by an instructional designer from instruction designed by someone without instructional design training should be the following: the instruction is learner-centered and goal-oriented, focuses on real-world performance with outcomes that can be measured in a reliable and valid manner, employs empirically derived principles, and is typically the result of a team effort (Gustafson & Branch, 2002). Considering these characteristics with the range of choices educators and designers make when developing instructional programs is the point of this section. The intersection between important characteristics of instructional design and exploring cognitive load and student satisfaction with learning online suggests a discussion on evaluating achievement or performance, the selection of media and delivery mode, the alignment of design with learning and motivation principles, and exploring evaluations as a necessity, not just for the student and instructor, but also for the field of instructional design practice.

Evaluating Achievement or Performance

Determining the effectiveness or quality of an online course, whether that course is provided through academia or business, is nearly always a concern. The concern reflects an assertion that assessment drives student learning, which centers assessment in both the design process and the student learning experience (Biggs, 1999; McLoughlin & Luca, 2001; Ramsden, 1992). Since assessment is central to systematic instructional design, the technique used to evaluate those assessments, and thereby program effectiveness, must also be a central concern to instructional designers and instructors. Depending upon the environment within which the instruction is provided (.e.g., business vs. academia), there exist differing approaches by which evaluations or assessments are constructed. The Four Level Kirkpatrick model is an approach to evaluating training programs commonly used in business, whereas academia tends to use formative and summative evaluations with a wide variation in practice. Looking closely into the practice of evaluating online instructional designs, there arise concerns with the established

Kirkpatrick Four Level model, as well as differences to implementing formative and summative evaluations.

Evaluation processes as they are perceived and employed by instructional designers incorporate two critical features: that assessment reveals the extent to which instructional objectives are met, and that the focus is learner-centered, which can be used as an information source to subsequently improve the instruction (Dick & Johnson, 2002). These two features reveal the nature of two evaluation strategies that are bread and butter to instructional designers: summative and formative evaluations. In the context of online learning and this study, summative evaluations tell us how effective the design *was* for the students seeking to fulfill the instructional objectives. Formative evaluations, by contrast, tell us how effective the design *is* and allows the instructor or designer to make decisions to improve the design. This temporal feature of evaluation types demonstrates the dual responsibility of the instructor and instructional designer, while also suggesting a hidden assumption that learning is an individual experience by virtue of a need to adjust instruction. This assumption explains the variations in learner performance under conditions that previously were successful, and the continual adjustments instructors and instructional designers must make to improve the odds of successful (as measured by assessments) learning. Clearly, the relationship between strategies of instruction and strategies of assessment must be aligned. Likewise, evaluation strategies used to ensure this alignment remains true become especially critical when the context of learning is made more complex by employing a wider array of media or using an ALN. Amongst the evaluation strategies available, the most enduring in the world of business is the Kirkpatrick Four Level model.

Kirkpatrick's Four Level model is nearly 41 years old. The Four Levels, Reactions, Learning, Behavior, and Results reflect different types of summative evaluations; however, as Kirkpatrick published his model in 1959, the distinction between summative and formative evaluations would not appear for another ten years (Dick, 2002). The following briefly describes the Four Level model. In Level 1, *Reactions*, an assessment of learner reactions or attitudes is made to essentially measure satisfaction (Kirkpatrick, 1995). In Level 2, *Learning*, assessments are designed to determine whether the "…principles, facts, and techniques were understood and absorbed by trainees" (Kirkpatrick, 1996, p. 56). In Level 3, *Behavior*, assessments are designed to determine the extent of transfer, or whether learners "…change their on-the-job behavior because of training" (Kirkpatrick, 1996, p. 56). In Level 4, *Results*, the general strategy is to collect business data, such as changes in sales, higher productivity, larger profits, reduced costs, less employee turnover, or improved quality that might be attributed to training (or learning).

Prominent researchers point to the failings of the Four Level model. For example, the model is largely considered a summative evaluation, where the approach is "…typically applied after training is completed to determine reactions, learning, and subsequently behaviors in order to validate the work of the training organization and to be persuasive with top management in the future" (Dick, 2002, p. 151). Another example is the conclusion of a meta-analytic review of the literature that finds the Kirkpatrick model "…through its easily adopted vocabulary and a number of (often implicit) assumptions, can tend to misunderstandings and overgeneralizations…" (Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997, p. 342). Among the misunderstandings and overgeneralizations made about this model are the following three assumptions: a) the levels reflect "steps" arranged in ascending order by the value of the information they provide (Alliger & Janak, 1994; Newstrom, 1978); b) that there exist causal relationships between the levels (Alliger & Janak, 1994; Hamblin, 1974); and c) the levels are positively inter-correlated (Alliger & Janak, 1994; Newstrom, 1978). Positive inter-correlation used within this context means that for positive results at the highest level to be achieved, one must have positive results in the immediate preceding level. The efforts of Alliger and Janak (1997) would seem to indicate that any transfer between Level 1 and Level 2 are inconclusive, while the authors also admit their results are based on only a few studies. Holton (1996) also criticizes the lack of definition of causal relationships between reactions, learning, or behavior and suggests an alternative model that eliminates Level 1, while instead "…emphasizing validation, learning outcomes and three learning variables: ability, motivation and environment" (Schankman, 2004, p. 2).

Brinkerhoff (1988) criticizes the Kirkpatrick model in that high-order skills might be unfairly evaluated since observing their execution in the workplace may not be safe, cheap, or possible on a regular basis, thereby restricting an accurate evaluation of skill transfer. Brinkerhoff (1988) presents a six-step model that emphasizes formative evaluations and the reuse of information to successive steps. The steps include a) goal setting; b) program design; c) program implementation; d) immediate outcomes; e) intermediate outcomes; and f) impact and worth. The evaluation strategy as argued by Brinkerhoff must be capable of assessing higher-order skills and include a formative element to permit course improvement through the identification of elements requiring revision. Similar to Kirkpatrick, Brinkerhoff's model is intended to serve the business environment.

Other approaches to the Kirkpatrick model include one by Walter Dick (Dick, 2002), who argues to make use of the results from Levels 1 and 2 as formative data to further inform design, and to apply a similar view to Levels 3 and 4 to ask new questions of supervisors, peers, and subordinates to explain the results and also inform the training design. While Irlbeck, Kays, Jones, and Sims (2006) argue for a different approach to instructional design to "…use what we know about distance education to enhance the online learning experience, and at the same time ensure that the models used to inform the creation of online learning experiences are relevant to the pedagogy that embodies the learning environment" (Irlbeck et al., 2006, p. 172). Irlbeck et al. present the theoretical premises of instructional design and the gaps that lie between their prescriptions and online environments. Next, they present a case that employs an emergent approach to instructional design for online distance education. From these arguments, the authors present the Three-Phase Design (3PD) Model based on work by Sims and Jones (2003). Guiding this model is the goal to maintain quality of the instructional program by developing the developer (i.e., the instructor) through scaffolding and faculty development opportunities. The model specifically addresses course enhancement with media and interactions as evidenced by the use of an *interactive architect* who is responsible for creating the design specifications and being active in a quality review. While this model does not specifically address training or learning evaluations, as in the case of the Kirkpatrick Four Level model, the fact that substantial effort is being made to develop models or approaches that address the complexities of online learning speaks volumes about the need in the field. With yet another formal criticism against the Kirkpatrick Four Level model, Bates (2004) furthers the argument that the model is inadequate in its ability to address summative and formative evaluation needs. This growing argument might shift some practitioners to explore or research using the 3PD model, and through this process build evidence of its utility. For now, too little has been published on the 3PD approach to provide guidance.

How do these evaluation approaches contribute to improving our means to consistently produce effective instruction for online learning? The issues discussed with the Kirkpatrick model would seem serious enough to warrant restraint in using the model. The perspective that *liking* does not contribute to *learning* is part of the longstanding argument that educators should not be in the entertainment business, yet entertainment might be conceived as a motivator to learning (Prensky, 2002). The critical concern with conducting an evaluation is that the evaluation reflects an understanding of the key variables and their interactions. Without such an understanding, the measurement misleads results. Alliger et al. (1997) suggest in their concluding remarks that the Kirkpatrick model can tend toward misunderstandings and overgeneralizations, which strengthens the position that the relationship between *reaction* and *learning* remains unknown. This unknown weakens the utility of the model to determine the effectiveness of an instructional design solution. The only way to improve an approach to evaluate online instructional designs is to understand better which variables express the most influence and more about the nature of the relationship between those variables. As there are many variables to consider, the case to argue is to constrain the many variables worth considering by returning to the Kirkpatrick Four Level model, where the approach can be further simplified to the following: reaction, learning, transfer, and effect. While previous efforts have failed to find the elusive connection between reaction and learning, finding that connection will strengthen the revised approach to evaluating online learning that is needed. One strong strategy would be to take the position of the subsequent level, learning, and to study what about that level might be influenced by variables in the previous level, reaction. With learning being characterized by mental effort, it would then make rather simple sense to focus the inquiry on a learner’s reaction to that mental effort.

Selecting Multimedia, Internet-Channels - The Complexity of Options

Instructional messages can be delivered in many formats, some of which even experts consider to be "dazzling" (Mayer, 2005). Instructors and instructional designers create or leverage *instructional messages* to foster learning. The format of such messages can include print materials, audio only media, audio and video, and some of these materials can be static or dynamic, such as with animation. Computers with appropriate software allow for the creation of many different possible formats and combinations. Still images or narrated text can be integrated into an instructional message together with animations depicting processes. Such messages can be relatively simple and created with free software available for any computer. These messages can also be highly complex, requiring construction with specialized software or hardware. Messages can also make use of shared resources available with a connection to the Internet and a free account with a service provider, or the messages can use specialized content or material available only through paid service provider accounts with restricted access. Messages can be designed for specific learner audiences, or they can be designed for mass consumption to cover large populations. The choices and opportunities for constructing (or making available) instructional messages are vast. From this, a construct to describe multimedia instructional messages would be any such communication intended to foster learning (Mayer, 2005). The designs used to impart learning that make use of multimedia components should follow what is known about how people process information. Mayer explains that the "…cognitive theory of multimedia represents an attempt to help accomplish this goal by describing how people learn from words and pictures, based on consistent empirical research evidence…and on consensus principles in cognitive science…" (Mayer, 2005, p. 32).

Mayer's work is timely and would seem to be of great value, given the changes taking place in higher education. Research efforts into trends in higher education from around the world indicate the use and integration of media materials, and incorporation of network-based instruction, such as ALNs, is increasing. Allen and Seaman (2007) report over 20% of all U.S. higher education students took at least one online course in the fall of 2006. Allen and Seaman further report that seven of the eight major discipline areas are experiencing roughly (24% to 34%) equal penetration of programs being offered in an online format. Linden Labs (2009) recently reported that world-wide users have spent more than one billion hours in Second Life. While this statistic reflects all users beyond only higher education use, the number is an important trend to watch as institutions of higher education are becoming interested in applying Second Life as instructional strategies. Emerging communication technologies, collectively labeled as *Web 2.0*, are catching the attention of educators and researchers (Garrison & Akyol, 2009). These technologies include wikis, blogs, instant messaging, mashups, Internet telephone, social bookmarking, social media sharing, and social networking sites. Garrison and Akyol (2009) observe that these communication technologies "…are not congruent with teacher-centered learning environments where the teacher is the main source of knowledge and the learner passively receives this information without much reflection or discourse" (p. 22). The suggested result from the collective adoption of these technologies is a paradigm shift to a learner-centered, socially constructed approach to teaching and learning. From another perspective, Shea, McCall, and Ozdogru (2006) examined adoption trends of the Multimedia Educational Resource for Learning and Online Teaching (MERLOT) among higher education faculty. The 18.46% overall increase in visitors from January 2003 to May 2005 Shea et al. report can be interpreted as an indication that educators in higher education are increasingly looking for resources, such as MERLOT, to guide them in their selection and use of multimedia elements within ALNs. The lure that Garrison and Akyol (2009) suggest lies behind the adoption of communication technologies, and perhaps behind other multimedia technologies as well, is that collaborative technology leads to discourse and engaged learning experiences. The researchers further reflect that only "…by capitalizing on the new and emerging communications technology can we practically overcome the constraints in higher education that have made the large lecture a necessity" (p. 23).

As the dazzle of technology lures adoption, Garrison and Akyol (2009) suggest we resist the seduction of technology, while Clark (1999) takes the matter further with the caution that multimedia instruction "…can also present increased opportunities to damage learning and discourage learners" (p. 28). Cook, Zheng, and Blaz (2009) agree: "there is a concurred view among researchers that multimedia may also impede learning and increase cognitive load if not appropriately designed" (p. 35). In an article reporting on research in information complexity and cognitive processing, Andres (2004) reports that "…presentation media (or format) had a direct impact on sustained attention, mental effort, information processing quality, comprehension, and learner confidence and satisfaction" (p. 73). Andres noted in his research findings that increased comprehension is associated with increased presentation modality. However, since this study explored the influence of multimedia on cognitive processing within the context of information complexity, Andres' finding should be considered that when modality is coupled with effective instructional design, the result should be improved comprehension. This is Clark's point (2001) in his extended debate with Kozma (1994): it is not the media itself that influences learning or motivation (Clark, Yates, Early, & Moulton, In press), but rather it is the instructional design that influences learning or motivation. Clark et al. instantiate this premise through two meta-analyses, where in the first Bernard, Abrami, Lou, and Borokhovski (2004) found no difference in learning or motivation from classroom or distance learning offerings (n=688), and in the second Sitzmann, Kraiger, Stewart, and Wisher (2006) found similar results (n=96).

Further following on Clark's logic, effective instructional design will include appropriate choice of modality to deliver the instructional message. Clark and Feldon (2005) quite effectively question the beliefs that multimedia a) is more effective than live instruction or older media; b) holds more motivational appeal than other delivery options; and c) by its nature is better received by different learning styles, and in this way permits maximizing instructional effectiveness. Even if the arguments Clark and Feldon present are only partially accepted, their case remains sufficiently robust to suggest that the practice of instructional design must include considerations regarding the instructional message delivery mechanism: whether the instructional message delivery mechanism consists of multimedia delivered locally or delivered through a network (i.e., ALN), the value of the mechanism is subordinate to the direct concerns that focus instructional design: achieving instructional objectives through careful and deliberate application of strategies that follow accepted or proven learning and teaching principles. However, the evidence is significant for concern regarding choice and implementation of multimedia or ALN components within an instructional design.

Aligning Design with Learning and Motivation Principles

To a practicing instructional designer, and based on the foregoing arguments, multimedia and an ALN instructional infrastructure should matter less than learning or motivation principles when designing instruction. Multimedia and ALN functions remain important components to a design, but decisions regarding them are subordinate to learning and motivation principles, which must provide final guidance on choices in the design. However, the reality is that any educational context may obviate the clean and simple guideline in the initial sentence to this section, leaving instructors or instructional designers coping with the constraints, limitations, issues, problems, and sometimes, advantages, offered by technologies that may already be in place. Since the most common educational context (i.e., regarding technical infrastructures and sometimes specific technologies) is one of pre-existing conditions that dictate some of the parameters that will affect design, the case must be made to argue for cognitive and motivational principles being aligned to guide designs using these technologies.

Stimulating and finding the means to sustain learner motivation when the learners work independently at a distance is a problem documented in the literature (Rowntree, 1992; Visser, 1998: in Keller & Suzuki, 2004). Keller and Suzuki (2004) identify some of the motivation problems found in distance learning scenarios: retention, isolation, and passivity (i.e., lack of engagement). Most interactions that occur in educational contexts tend to be spontaneous when the context is face-to-face classrooms, but in ALN environments, the technology can reduce spontaneity that in turn impedes interaction. The missing visual and auditory cues can create misunderstanding or confusion between instructor and student, between students, or even between student and content. One strategy that instructors often use to mitigate these problems is to increase course structure; however, increasing structure impedes spontaneity (Moore, 1993). Moore (1993) labels the space wherein instructional interactions take place, and from where miscommunications often originate, the *transactional distance*. The concepts that describe transactional distance are *dialog* and *structure*. To explain the concepts, Moore (1983) writes,

> Dialogue describes the extent to which, in any educational programme, learner and educator are able to respond to each other. This is determined by the content or subject matter which is studied, by the educational philosophy of the educator, by the

> personalities of educator and learner, and by environmental factors, the most important of which is the medium of communication (p. 157).

Regarding structure, Moore (1983) continues,

> Structure is a measure of an educational programme's responsiveness to a learner's individual needs. It expresses the extent to which educational objectives, teaching strategies and evaluation methods are prepared for, or can be adapted to the objectives, strategies, and evaluation methods of the learner. In a highly structured educational programme, the objectives and the methods to be used are determined for the learner and are inflexible. (p. 157).

Moore's term, dialog, can also be replaced by *interaction* since Moore's description reflects interactions between learner and educator. The relationship between interaction and structure is dynamic as an instructor will make adjustments to the instructional strategies during course delivery (Saba & Schearer, 1994). While making such adjustments in face-to-face scenarios is more readily accomplished (e.g., as an instructor notes incomprehension in a learner's face), making these adjustments in online courses may not be so quickly or easily accommodated (Chickering & Ehrmann, 1996; Moore, 1997; Yang & Cornelious, 2005).

Northrup (2001) believes that overcoming the transactional distance in online courses requires designing and creating interaction using systematic instructional design techniques grounded in learning theories and instructional methods. A grounded approach can generate intellectually challenging opportunities, eliciting deeper thinking and expanding students' critical thinking and problem solving skills. To address motivation elements, Keller (1987a, 1987b) developed the ARCS model (Attention, Relevance, Confidence, and Satisfaction) to integrate motivation into instructional design. Following grounded learning theories and motivation principles should improve the quality of the instructional design, but these guidelines should also consider existing technical infrastructures that may reflect the situational context of instruction and learning. The argument being made is that the alignment and implementation of learning and motivation principles will need to consider the affordances of *any* ALN technical features or other technologies that may be required for learning (e.g., SPSS software that is part of a statistics course or a Blackboard Learning Management System).

Instructional Design Concerns with Learning Online: A Summary

In support of the study scope to explore a possible relationship between perceived cognitive load and student satisfaction with online learning, this section addresses instructional design concerns with learning online. Through the discussion, the following guidelines emerged to direct this study:

- Focus evaluation of learning to include learner's reaction to mental effort
- Address the choice and method of implementation of multimedia or ALN components in a study on cognitive load and student satisfaction
- Address how learning and motivation principles will integrate with any ALN technical features or other technologies that may be required for learning

As the scope of the study is to accept or reject the null hypothesis, more discussion is appropriate to properly frame the construct of motivation within the context of online learning. In the next section, relevant research in motivation is explored to find guidelines for studying student satisfaction within the online learning context.

Relevant Research on Motivation

In the following section, current trends in motivation research are explored that argue for the inclusion of the context of learning becoming part of the study. The theoretical foundations for studying student satisfaction are presented and followed by multiple approaches for conducting studies on satisfaction. Finally, the situative context of student satisfaction within ALNs is discussed and explored as it evolved from research in best practices of organizing the learning environment.

Current Trends in Motivation Research: Context of Learning

Over the last decade and half, a shift has been taking place in research on motivation. "In the 1960s and 1970s, motivation was seen as an alternative explanation for a cognitive process" (Järvelä, 2001, p. 3). But "rather than stud[y] the interaction of motivational and cognitive processes, a battle developed regarding which of the two, motivation or cognition, was a better explanation of the phenomenon of learning" (Sorrentino & Higgins, 1986) in (Järvelä, 2001, p. 3). Accounting for problems in behavior and learning was attributed to information processing errors and cognitive limitations (Nisbett & Ross, 1980). Much of the research in the 1980s started with competence values, and motivation was determined by perceived expectations (Schunk, Ames, & Ames, 1989). Motivation was considered to be the influence behind emotions such as pride, shame, guilt, and a general self-concept of the ability to achieve specific goals (Bandura, 1986). And then, interestingly in the middle of the philosophical divide, the position that *motivation and cognition should be considered inseparable* was made (Sorrentino & Higgins, 1986). By the arrival of the late 1990s, educational psychologists recognized the need to emphasize the social nature of human learning, so they turned their interest to include context as it influences cognitive development (De Corte, 2000).

Several issues contribute to driving research to increase focus on including context to study motivation. Researchers adhering to socio-cultural, situative, or socio-cognitive perspectives question traditional motivation theory to adequately address situative motivation: how do learning activities provide support or constraints for learner engagement in learning, while at the same time how do learners' subjective appraisals of situations play a mediating role in their commitment to engage in learning? Understanding motivation in context is best achieved if conceptualized as a dual psychological and social phenomenon (Volet, 2001b). Motivation research has been slow to focus on developing or adapting contextual paradigms for study: focus was on the self, with the social elements and learning environment left in the background (Järvelä, 2001). It has been argued that applications of motivational theory have been limited by inadequate methods, designs, and descriptions of what is actually happening in classrooms (Blumenfeld, 1992; Hickey, 1997; Turner & Meyer, 2000). Research designs involve only one or two points of data collection, and there is a scarcity of descriptions of the classroom interactions (Järvelä, 2001).

To account for the need to understand the influence context extends onto motivation, Volet (2001a) argues that the future direction for research on motivation in learning should incorporate the socio-cultural conditions, which either support or constrain cognition, motivation, emotion, attitudes, and behaviors. Volet acknowledges that the major challenge is to conceptualize the learner in context and thereafter analyze the interactions. Volet (2001a) presents a conceptual model where the experiential interface centers a learner's interactions that in one dimension reflect a learner's cognitions, motivations, and emotions related to learning, and in another dimension reflect a learner's interactions with the learning context. Volet explains that when there is congruence between the two dimensions through the experiential interface, the learner will be engaged and productive in the instructional activities. Further, Volet stipulates that congruence is indicated when individual learning is tuned to the affordances of the learning context, and when the community of practice supports individual engagement in learning.

Volet's critical contribution is the perception that the learner-centered model should incorporate more than the immediate learning environment to include the socio-cultural environment that connects through the learner's experiential interface. A similar argument is made by Cole and Engeström (1993) where the authors identify the nature of influences a subject faces when working within a social system: mediating artifacts, rules, community, and division of labor. The parallels between Volet and Cole and Engeström are strong in reflecting a notion that engagement and production incur multiple influences that lie beyond the immediate, proximal, learning context. From this perspective, a model to study student satisfaction, expressed as a construct of motivation, will necessarily need to include the immediate learning context, as well to some degree the wider, socio-cultural conditions.

Theoretical Foundations for Studying Student Satisfaction

In the field of instructional design, John Keller is internationally recognized for his contributions in the area of motivational design for instruction. Approximately 26 years ago, Keller (1983) developed his motivational design model, which he grounded in theories of expectancy-value (DeCharms, 1968), reinforcement (Travers, 1977), and cognitive evaluation (Deci, 1975; Keller, 2006). Keller integrated these theories by using systems analysis to explain the context of the relationships between effort, performance, and satisfaction. The four categories of motivational variables are *attention*, *relevance*, *confidence*, and *satisfaction*, and from these Keller formed the acronym ARCS. The model includes a systematic, seven-step approach to embed motivational strategies into instruction (Keller, 1999). Each category emerged from a comprehensive review and synthesis of motivational concepts and research studies. Rather than preparing only a theoretical construct, Keller focused on building the model to support designers as they identify and solve particular challenges associated with motivation and the appeal of instruction. Towards this intent, the model includes strategies to support the design of materials, teaching styles, and overall course design. Recent empirical studies of the model confirm the model's validity (Huang, Huang, Diefes-Dux, & Imbrie, 2006; Keller & Suzuki, 2004).

The theoretical foundations of the ARCS model cover a relatively broad scope of research. In the model, the first category, attention, is included with the purpose of arousing attention and curiosity of the learner (Keller, 1983). Within the two conditions we need to take advantage of, we have perceptual arousal to stimulate the senses, inquiry arousal to stimulate curiosity, and variability to vary stimulus (Hirumi, 2005). Keller's theoretical basis for these originate from curiosity (Maw & Maw, 1968), perceptual arousal (Berlyne, 1964), and inquiry arousal (Kaplan, 1964).

The second category, relevance, is included with the intent to help learners associate their prior knowledge and to facilitate a recognition of the applicability of the material to be learned for the future. To achieve this, designers must incorporate goal orientation, to help students create and achieve goals, motive matching, to address specific needs, and familiarity, to relate to learner's previous experiences (Hirumi, 2005). Keller's theoretical basis for these originates from drive theories (Hull, 1943), needs hierarchy (Maslow, 1954; Rosenzweig & Murray, 1938), and need for achievement (McClelland, Atkinson, Clark, & Lowell, 1953).

The third category, confidence, is included to leverage the positive expectations towards learning tasks and ensuring that the experiences are meaningful. These support the development of confidence through the learning experience. To achieve this, designers must consider the learning requirements, with an acute awareness of expectations and the criteria for evaluation, the success opportunities, with an assurance that learners perceive they will be successful, and retain a sense of personal control, such that learners link their success or failure to their efforts and abilities (Hirumi, 2005). Keller's theoretical foundations leverage self-efficacy research (Bandura, 1977), learned helplessness (Seligman, 1975), locus of control (Rotter, 1954), and attribution theories (Weiner, 1974, 1979).

The fourth and last category, satisfaction, reflects the feedback mechanism between the learner and the instructor that is intended to reinforce learning behaviors. Arising from the opportunity to exercise or practice newly acquired knowledge or skills, satisfaction represents an internal emotion that can be coupled with extrinsic rewards. The theoretical basis Keller leverages are conditioning theory (Travers, 1977) and cognitive evaluation theory (Deci, 1975).

Satisfaction refers to a range of feelings, from positive to negative, about a learner's accomplishments and learning experiences. These feelings are intrinsic in the individual learner, are associated with an outcome that is perceived by the individual to be fair, and are influenced by extrinsic rewards (i.e., the situative learning context) (Dubuc, 2009; Deci, 1975). Satisfaction also functions in a feedback loop for *awareness* of *potential* satisfaction for particular behavior driven by *extrinsic* motivation, and in a feedback loop that supports *intrinsic* motivation (Deci, 1975). Deci's conceptual model (1975) is recreated in figure 3 below.

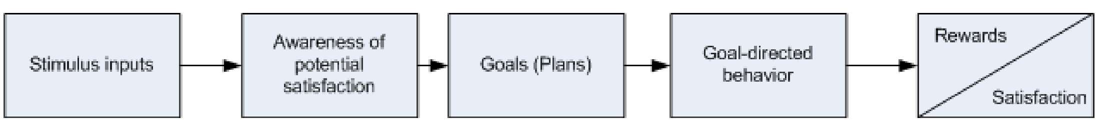

Figure 3. A conceptual model of the cognitive approach of motivation (Deci, 1975, p. 98).

Deci's view is that rewards may be (a) extrinsic related to drives, (b) intrinsic related to feelings of competence and self-determination (efficacy), and (c) change in affect relating positively to initiative behaviors. This view is further modified to reflect ongoing behavior changes as part of a dynamic system. The following recreated Figure 4, Deci (1975) incorporates the dynamics of change that initiates behavior with a feedback loop.

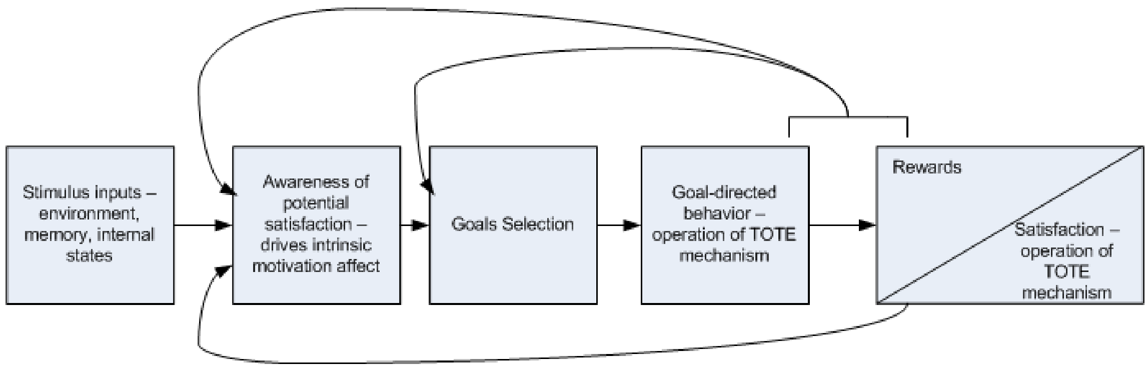

Figure 4. A conceptual model with a feedback loop in the cognitive approach of motivation (Deci, 1975, p. 122).

The model, incorporates the TOTE unit (Test, Operate, Test, Exit), which includes a comparative mechanism of input to "…some standard such as an adaption level, an expectation, etc." (Deci, 1975, p. 37). From Deci's model, satisfaction is (a) a component of motivation; (b) it is summative; but (c) it also represents an *expectation* for future rewards that serves to *initiate* or *support* cognitive behavior.

Deci's conceptualization of satisfaction functioning in a feedback loop explains the position taken by Song and Keller (2001) that "[m]easures of satisfaction would normally be taken after the learners had finished a given block of instruction; hence they would be taken less frequently and would be more summative in nature unless the program were long enough to change the incentive structures and other satisfaction elements" (p. 8). In this perspective, satisfaction can serve as a general measure of a learner's reaction to the influences from the learning context and the mental effort of learning. Identifying the context of learning as a separate influence from the mental effort of learning becomes useful to determine the variety and strength of categories of influence on student satisfaction. Student satisfaction "rolls up" a collective set of reactions to an online learning experience that is responsive to extrinsic motivators, while still serving to strengthen or, alternatively, weaken intrinsic motivation. This translates to the perspective that students' self-measure of their satisfaction with the learning experience is complex. Thus, from Deci and Keller, additional components that contribute to student satisfaction should include constructs on goal selection, purposive behavior, and the awareness of potential rewards or satisfaction. In addition to these goal-related constructs, satisfaction should include aspects of the learning context and, as will be argued within this chapter, cognitive load.

Research Approaches to Studying Student Satisfaction

Among those who have contributed to the research dialog on satisfaction in education, Shea, Fredericksen, Pickett, and Pelz (2004) identify that good learning requires a centering on the learner, knowledge, assessment, and community and further point to Chickering and Gamson's *7 Principles of Good Practice and Principles on Learning Environments* (Chickering & Gamson, 1987; Chickering & Ehrmann, 1996). Shea et al. report that every semester they conduct surveys of participating faculty and students through an integrated, web-based data collection infrastructure. Within the survey, assessment questions cover the following themes: (a) students' feelings about the experience; (b) students perceiving disadvantages to the online format compared to the classroom; (c) students or faculty finding other downsides, such as too distracting, feelings of isolation, etc; and (d) inquiring into how the online environment compares to the classroom overall. The assessment uses 35 Likert-type and open-ended questions, which were framed using the 7 Principles. Additionally, one-third of the questions were based on the *Flashlight Evaluation Handbook and Current Student Inventory* (Ehrmann & Zuniga, 1997). In 2001, the researchers collected 935 student surveys, which represented approximately 26% of the enrollment – an admittedly low rate of response. The researchers employed Spearman's rho to determine if a significant correlation exists between satisfaction and reported learning, for which both had four distinct data points: (a) quantity of interactions with the instructor; (b) quality of instructor interactions; (c) quantity of interactions with fellow students; and (d) quality of interactions with fellow students. The *quality* construct was defined using the 7 Principles. Their findings indicated correlations exist, significant at the 0.01 level (two-tailed), between satisfaction and reported learning. Correlations were in general stronger for interactions that included the instructor than for interactions with fellow students. From the open-ended questions, respondent commentary suggests that "…meaningful learning requires active student engagement. When students are active participants, they tend to report excitement; when they are passive, they tend to report disappointment" (Shea et al., 2004, p. 363). In addition, starting with the premise that the technology permits increased comfort and level of thought, which might contribute to learning and satisfaction, the researchers also employed Spearman's rho to determine if there exists a correlation between the amount of thought students put into their online discussion comments and with the amount of comparable effort put into classroom discussion. The researchers found significant correlation between amount of thought invested in discussion responses, and learning and satisfaction.

While the 7 Principles do not specifically refer to student satisfaction, achievement of satisfaction is alluded to by following the guidelines derived from the principles: (a) contact between students and faculty; (b) student reciprocity and cooperation; (c) prompt feedback; (d) time on task; active learning techniques; (e) communication of high expectations; and (f) respect for diverse talents and ways of learning. While stated sometimes differently, these principles tend to arise in the educational satisfaction literature in ways similar to the research by Shea et al. (2004).

Conducting an analysis to determine the relationship between environmental (i.e., “context”) variables and student satisfaction, Thurmond, Wambach, Connors, and Frey (2002) leveraged 12 questions in an evaluative instrument based on the 7 Principles for web-based training. The full instrument included 57 questionnaire items that were developed using the database maintained by the Flashlight Program (see http://www.tltgroup.org/flashlightP.htm). 15 items pertained to demographics and educational experience. 40 items addressed student perceptions of outcomes, educational practices, and technology use. Two open-ended questions inquired on the perceived best thing about the course and on suggestions for improvement. The sample size was 120 from one university. For the analysis, the researchers selected 12 items for a secondary analysis where they applied Astin’s (1993) I-E-O (Input, Environment, and Outcome) conceptual model. For the Input variables, the research team used five items that reference student characteristics collected at the beginning of the program. These questions were framed on computer skills, knowledge with electronic communications technologies, number of web-based courses taken, distance from campus, and student age. For the Environment variables, six items were based on the 7 Principles. The Outcome variable was students’ satisfaction with the course. Analysis procedures included correlation and hierarchical regression (using a block method). Statistically significant bivariate correlation at a level of $r \geq .50$ was found between student satisfaction and timely feedback, variety of ways of assessing, and knowing the instructor. Among the predictors that were significant, there were three correlations between received timely comments and knowing the instructor ($r = .52$, $p < .01$, $n = 117$). Another statistically significant correlation was found between variety of ways of assessing and knowing the instructor ($r = .68$, $p < .01$, $n = 117$). The final statistically significant correlation was between time studying and knowing the instructor ($r = .50$, $p < .01$, $n = 117$). From the hierarchical multiple regression analysis, the student characteristics (the input variables) were entered as a group and accounted for 6.5% ($R2 = .065$) of the variance, but it was not statistically significant to predict student satisfaction. Conducting the same analysis on the grouped instructional activities and interactions, the environment variables accounted for 52% of variance ($R2 = .52$). The final regression analysis, the overall multiple regression equation that included input and environmental variables, accounts for 58.5% of the variance in student satisfaction outcomes and was statistically significant ($F6, 21.5 \leq .001$). In summary, the findings include having a variety of assessment strategies, team or group work, timely feedback, and an instructor's active participation in web-based discussions as being the most influential variables to satisfaction.

Grant and Thornton (2007) followed a qualitative study method. The researchers developed an eight item survey based on Chickering and Erhmann's (1996) research and adapted from the database maintained by the Flashlight program. This survey was delivered electronically to 14 university faculty members, who were at the time teaching online. Of the 14 surveys distributed, the researchers received 12 completed. Following the receipt of the completed surveys, the researchers convened personal interviews with all faculty respondents, and thereafter conducted two focus group sessions to validate what was learned. Faculty responses were collectively analyzed using a grounded theory analysis method by Glaser and Strauss (1967) to identify similarities, patterns, and emerging themes. The researchers also distributed a seven item questionnaire to 150 students who participated in the online courses. The items were open-ended and asked students about the following: (a) their satisfaction with the instructor's handling of the course; (b) how the instructor could improve the course; (c) how the instructor encouraged student participation and interaction; (d) if course objectives were met; (e) any interactions the student had with the instructor outside of class; and (f) additional comments. The study results identified three themes of best practices for online instruction as being course design, instructional effectiveness, and interactivity or interconnectivity –which, if properly implemented, can positively influence student satisfaction.

Summers, Waigandt, and Whittaker (2005) examined differences between online distance education and traditional classroom learning for an introductory undergraduate statistics course. 38 undergraduates enrolled in a nursing program were selected to participate in the study. The study employed two instruments for measurement: a measure of statistics knowledge, and a measure of student satisfaction with the course. The first instrument was a test exam, while the second was derived from evaluation forms developed at the University of Washington's Office of Educational Assessment. The researchers employed independent-samples t-tests to explore whether significant differences existed between statistics knowledge and student satisfaction. Since not all respondents answered every item, n, and subsequently the degrees of freedom, varied in each analysis. The satisfaction measurement instrument included 16 questions related either to the instructor or to the course. Each of these 16 questions asked that respondents rate on a scale of 1 – 5 (i.e., 1 is lowest, 5 is highest) their level of satisfaction. The findings as regards the perceived satisfaction with the instructor found statistical significance at the $p < 0.01$ level for instructor's explanations, and at the $p < 0.05$ level for instructor's enthusiasm, openness to students, and interest in student learning. The findings as regards the perceived satisfaction with the course found statistical significance at only the $p < 0.01$ level for two items: class discussion and evaluation and grading. Overall, the researchers found differences in the level of student satisfaction: instructor explanations, enthusiasm, openness and concern, interest in student learning, group discussions, quality of questions and problems, and evaluation and grading were all deemed less satisfactory in an online course against a traditional class on the same topic. However, in the narrative within the conclusion, the researchers note that content, assignments, and assessments were the same with both course modes, as well as that no adjustment to the instructional strategies were made to compensate for students who were not in the face-to-face class. The researchers explain: "…the differences were most likely significant because we did not make our class more amenable to an electronic format" (Summers et al., 2005, p. 246).

In a study to detail student perceptions of useful and challenging characteristics of online learning, Song, Singleton, Hill, and Koh (2004) note that flexibility, convenience, diversity of learning experiences, immediacy in instructor feedback, and sense of community contribute to student perceptions, but that satisfaction is more associated to course design, the comfort level with technology, learner motivation, and time management skills. To reach this finding, Song et al. solicited study participation from graduate students at a large research university. Seventy-six students participated in the survey, and 14 participants agreed to a follow-up interview. The researchers therefore followed a mixed-mode study format, as they used both quantitative and qualitative data. This approach permitted the researchers to validate and cross-check findings. Unfortunately, the researchers did not include in their narrative the analytical details for the process by which they analyzed their data.

Young and Norgard (2006) developed a student survey tool after completing a review of the literature and found that course design, student-student interactions, timeliness of student-instructor interactions, technical support, and depth of experience with the medium (i.e., online learning management systems) contribute to student perception of satisfaction. These findings are the result of a survey delivered to 913 enrolled students, whereof 233 (a return rate of 25%) completed all or part of the instrument. Survey items included student perceptions about course design, interaction among course participants, course content, technical support, and benefits online courses might have over face-to-face courses. The items used a four point Likert scale with response options ranging from strongly agree to strongly disagree. Open-ended response items followed each question. The researchers performed a one way ANOVA with the student characteristics being the independent variable and response question items being the dependent. To determine which specific characteristics proved to be significant following the ANOVA analysis, the researchers used Dunnett's T3 post hoc multiple comparison test. Regarding limitations to the survey, the researchers note that the small sample size may be unrepresentative of students taking online courses; only 28% of the faculty who teach online gave permission to include the study in their online courses; and the survey came available towards the end of the semester when participation may have been affected by final exams and holiday plans.

To summarize the review of the included research studies, Chickering and Gameson's 7 Principles seem to comprise a robust compilation as evidenced by how other researchers' work fit well within their list. Shea et al. overtly refer to the Principles in their study. Thurmond et al. leveraged 12 questions from a data bank built from the 7 Principles in their study. Grant and Thornton's three themes align well with the 7 Principles: course design and instructional effectiveness can fit with time on task, active learning techniques, and respect for diverse talents and ways of thinking; interactivity and interconnectivity fit with student/faculty contact, student reciprocity and cooperation, prompt feedback, and communication of high expectations. The Summers et al., Song et al., and Young and Norgard findings seem to focus in a similar fashion to Grant and Thornton with the 7 Principles on the communication and interactivity elements of the course design.

The Situative Context of Student Satisfaction in ALNs

The Chickering and Gamson (1987), Chickering and Ehrmann (1996) 7 Principles identify the situative context of well organized, effective learning environments, but they are one viewpoint. In an original report funded by the Alfred P. Sloan Foundation, Dziuban, Hartman, Moskal, Brophy-Ellison, Shea, and Lorenzo (2007) referred to three independent literature reviews to guide efforts to develop a survey instrument on student satisfaction: Muilenburg and Berge (2005), Sun, Tsai, Finger, Chen and Yeh (2008), and Lorenzo (Dziuban et al., 2007, Appendix A). In Table 1, a comparison of the findings by Dziuban et al. is made with the Chickering and Gamson 7 Principles. While there are differences, it should be pointed out that the Chickering and Gamson 7 Principles function well when expanded upon by current research.

Table 1

Comparison: Chickering & Gamson's 7 Principles and Recent Research

Chickering and Gamson (1987)	Muilenburg and Berge (2005)	Sun, Tsai, Finger, Chen & Yeh (2008)	Dziuban et al. (2007)
Contact between students and faculty	Administrator and Instructor Issues	Computer Anxiety	Instructor Attitude and Selection
Student reciprocity and cooperation	Social Interaction	Instructor Attitude	Instructional Activities
Prompt feedback	Academic Skills	Course Flexibility	Virtual Teams and Collaborative Learning
Time on task	Technical Skills	Course Quality	Feedback Communication and Rewards
Active learning techniques	Learner Motivation	Perceived Usefulness	Online Learning Design
Communication of high expectations	Time and Support for Studies	Perceived Ease of Use	Characteristics of Students Who Withdraw
Respect for diverse talents and ways of learning	Cost and Access to the Internet	Diversity of Assessment	Characteristics of Students Who Complete
	Technical Problems	Technical Problems	Importance of Student Services

Dziuban et al. then used a mixed methods research approach to further explore this space of student satisfaction within ALN environments. The researchers took a quantitative approach by surveying 1,325 students across two campuses and ran a principal component analysis of the respondent data. The team also took a qualitative approach by convening multiple student focus groups to capture student perspectives. The derived results from each analysis were set into a table matrix to determine correspondence, which was better than 50%. The team identified eight dimensions that they call the Sloan Model of Student Satisfaction in ALNs (Sloan Model), which are the following:

(a) Reduced Ambiguity; (b) Enhanced Student Sense of Value in Courses; (c) Reduced Ambivalence; (d) Clarified Rules of Engagement; (e) More Individually Responsive

Learning Environments; (f) Improved Interaction; (g) Augmented Learning; and (h) Increased Freedom (Latitude).

In another comparison, the eight dimensions of the Sloan Model would seem to be a superset of the Chickering and Gamson (1987), Chickering and Ehrmann (1996) model. In Table 2, by using the descriptors associated with each of the eight dimensions of the Dziuban Model, we see that the 7 Principles fit within the eight dimensions of the Sloan Model. There remain, however, two areas identified in the Sloan Model that are not as well expressed in the 7 Principles: *Reduced Ambiguity* and *Increased Freedom*. This is not to say that the 7 Principles are in any way lacking, merely that the expression of the Principles do not identify these areas in the same way as the Sloan Model.

Table 2

Comparison: Sloan Model and Chickering & Gamson's 7 Principles

Dziuban et al. (2007)	Sloan Model Descriptors	Chickering & Gamson (1987)
Reduced Ambiguity	Reduced uncertainty about how to succeed in course Reduced work and family disruption and constraints Improved sense of control	
Enhanced Student Sense of Value in Courses	Faster assessment of assignments Higher levels of recognition Better able to audit course progress	Prompt feedback
Reduced Ambivalence	Reduced stress over course completion Increased degree of course access Increased connectedness	Student reciprocity and cooperation Contact between students and faculty
Clarified Rules of Engagement	Course expectations clear from the onset Fairer performance assessment Clearer definition of involvement More opportunity to collaborate	Communication of high expectations
More Individually Responsive Learning Environments	Continually connected as an individual Encouraged to be actively engaged Facilitated access to outside sources Able to audit course progress	Active learning techniques
Improved Interaction	Anywhere, anytime communication with peers Anywhere, anytime queries to instructors Sustained conversations Rapid access to independent experts Better able to find, evaluate, and use information (information fluency)	Time on task
Augmented Learning	More room for individual creativity More individual empowerment to learn Expanded course boundaries	Respect for diverse talents and ways of learning
Increased Freedom (Latitude)	Self-managing the learning environment Expanding beyond the current course Alternatives to large lecture classes Reducing prohibitive logistics	

The two missing dimensions, *Reduced Ambiguity* and *Increased Freedom*, do reflect important aspects of student satisfaction as they focus on control of learning within the context of busy lives, and an opportunity to expand learning for those students who desire to range beyond the course design. These dimensions would seem to express important criteria that demonstrate the value students place in online courses.

In developing the Sloan Model, Dziuban et al. followed a unique path to derive results, which are (a) largely independent of institutional influence, and (b) used students as primary contributors. By contrast, Young and Norgard (2006) developed their instrument as a result of the literature review only. The inherent benefit in the Sloan Model is the potential to reduce the risk of institutional bias within the survey instrument. The Sloan Model instrument is unfortunately long (74 questions) and would be difficult to employ and interpret as a formative (or even summative) evaluation tool for an online instructor. This research approach by Dziuban et al. consists not only of dimensions that describe characteristics of context for studies on student satisfaction, but it also presents a procedure to extract student perspectives that can be later used in a general survey to gather data regarding the context of student satisfaction within ALNs. The general method of employing students to draft the questions through a guided process that includes group dialog is a critical component of the procedure. Considered this way, the Sloan Model is both structure and process, which can be readily used to capture the situative context of ALN.

Relevant Research in Cognition

In this section, an overview of the information processing model is presented to build a discussion foundation for Cognitive Load Theory. This initial topic is followed by a brief discussion of the influence of expertise on learning as explained by the Dual Processing Theory. Next, an orientation to Cognitive Load Theory is presented, which is followed by a brief discussion on whether cognitive load should be avoided. The final topic covers research efforts to measure cognitive load.

An Overview of the Information Processing Model: Past and Present

Consider this working definition for learning as espoused by cognitive psychologists:

> Learning is a constructive, not a receptive, process. In the view of most cognitive psychologists, learning is a product of the interaction among what learners already know, the information they encounter, and what they do as they learn. Learning is not so much knowledge and skill acquisition as it is the construction of meaning by the learner (Prawat, 1996; in Bruning, Schraw, Norby, & Ronning, 2004, p. 6).

According to the information processing model, there are three stages to information processing: (a) the encoding of stimuli through the sensory register; (b) the passing of information into temporary storage of short-term or working memory; and (c) the recording of information for permanency in long-term memory (Woolfolk, 1993). The model also includes the concept of executive control, where a system provides monitoring and guidance to the whole process of sensory input, encoding, short-term/working memory activation, and storage into and retrieval out of long term-memory. Out of this process, learning might emerge as a result of sensory encoding into long-term memory storage and retrieval: "…meaning is constructed partly from objective reality and partly from the way we organize the information based on our existing knowledge" (Woolfolk, 1993, p. 245).

Short-term or working memory in the model is quite important for perception, and thereby an influence on learning. In the information processing model, encoded sensory information is first shuttled into a temporary working space prior to storage for the long-term. Research by Miller (1956, 1994) demonstrated that information processing is constrained to the magical number seven, plus or minus two (7±2), chunks of information. Peterson and Peterson (1959) then showed that not only is size a constraining factor, but also duration: from the Brown-Peterson paradigm, it was demonstrated that information decays from some loss by 3 seconds to near complete loss by 18 seconds (Bruning et al., 2004). Waugh and Norman (1965) extended Miller's work by studying the influences of time on forgetting and found that increasing the amount of information increased forgetting regardless of time. Greene (1992) further modified this understanding to one of inserting interference into the model: interference contributes more to forgetting than the time duration. Work by Ericsson, Chase, and Faloon (1980) demonstrated that information could be chunked to improve the capacity of short-term memory. The concept of chunking involves grouping information pieces to permit leveraging a principle of inclusion. Following this principle, the separate letters A, B, and C can be considered three separate items to remember, but through chunking, the three letters are stored as the first letters in the English alphabet, and so are stored as a single chunk, ABC. A contemporary view of working memory is that the model consists of three components: a central executive system and two slave systems, the articulatory loop and the visuospatial sketchpad (Baddeley, 1986, 2001). While the functions of the articulatory loop and the visuospatial sketchpad act as simple recorders of audio or visual information, they have limited capacities, which if overreached can impact the resources of the executive system (Ashcraft, 1994). In a more recent and thorough review of research on memory limitations, Cowan (2001) effectively argues a revision to Miller's 7±2 limits to four assumptions: (a) the focus of attention has a limited capacity; (b) the limit of focus averages about four chunks in normal adult humans; (c) there are no capacity limits on other mental faculties, with the exception that some are constrained by time and a susceptibility to interference; and (d) deliberately recalled information, whether what is recalled is the result of a recent stimulus or from long-term memory, is restricted to the limit in the focus of attention (Cowan, 2001, p. 91). Cowan defines the term *chunk* as "…a collection of concepts that have strong associations to one another and much weaker associations to other chunks concurrently in use" (p. 89).

From this body of work emerge important principles that impact learning: (a) short-term or working memory has a capacity limited to about four chunks; (b) information stored in short-term or working memory has a limited time until it becomes lost; (c) interference will increase forgetting; (d) short-term or working memory capacity can be improved by using chunking strategies; (e) whether the information is visual or audio based, there are limitations to how much can be processed for long-term storage; and (f) recalling information, which can refer to previously learned information that exists in long-term memory or to recent stimuli, will have the same focus of attention limitation of four chunks. Information processing theory connects with the purpose of this study by providing a foundation to the concepts that support cognitive load theory. In the following section, expertise is discussed to present the dual processing theory that is also part of the foundation of cognitive load theory.

Dual Processing Theory: A Brief Discussion of Expertise

In the previous section, Woolfolk's (1993) perception of the construction of meaning is presented that includes the idea that pre-existing knowledge will influence the way we organize information and construct understanding. Clark's (1999) description of mental effort is the "…conscious, deliberate and cognitive elaborative processing required to learn novel declarative knowledge…" (p. 28) suggests that learning might be possible with the opposite of "…conscious, deliberate and cognitive elaborative processing…." The dual-process theories of cognition describe information processing occurring simultaneously on parallel pathways. On one hand, slow and effortful processing suggests that mental effort is following a controlled pathway governed by the limitations from information processing theory, as described in the previous section. The other hand is one of fast and effortless, non-conscious processing that suggests mental effort is automatic.

Automatic processing, or the concept of *automaticity*, has been described as "… the absence of active conscious information processing, taking place when the individual relies on a structure of the situation representative of its underlying meaning…"; or when information appears "…familiar in structure, are overlearned, and that seem to fit well into…anticipatory schemata" (Salomon, 1984, p. 648). Salomon notes that automatic processing also means that when information is already known, one can ignore it. Effortful processing means that less can be ignored and deeper processing must take place. When schemata are more developed, as is the case with individuals with expertise, more declarative knowledge can be *chunked,* so new information processing has less demand on working memory (Feldon, 2007; Sweller, 1988). Novices without the schemata cannot process information as effortlessly as those with experience since their lack of conceptual framework makes cognitive processing less efficient than an expert's. As cognitive processing demands increase to manage novel declarative information and range beyond a learner's existing schemata, the more the processing must be conscious, deliberate, and constrained by limits of working memory. In summary, dual processing theory provides a basis to recognize the influence and effect of existing knowledge or experience on learning.

Orientation to Cognitive Load Theory

Emerging in the 1980s from information processing theories, cognitive load theory (CLT) developed and expanded substantially in the 1990s by researchers from all over the globe (Paas, Renkl, & Sweller, 2003). CLT developed into a major theory that presents an investigational framework for cognitive processes and instructional design. “By simultaneously considering the structure of information and the cognitive architecture that allows learners to process that information, cognitive load theorists have been able to generate a unique variety of new and sometimes counterintuitive instructional designs and procedures” (Paas et al., 2003, p. 1).

Schemata are stored in long-term memory, but their construction into long-term memory is the result of processing within working memory (Sweller, Van Merrienboer, & Paas, 1998). The prime concern of CLT is the efficiency with which information is processed in working memory. Learning requires engagement in cognitive processing, or mental effort, but a learner’s processing capacity is severely limited (Mayer & Moreno, 2003). Recognizing the implications of cognitive load is necessary for the development of efficient and effective instructional design. Cognitive overload, where a learner’s needed cognitive processing exceeds capacity, or the risk for overload, must be managed to support *meaningful learning* while avoiding potentially damaging learning. Mayer and Moreno (2003) define meaningful learning as “…deep understanding of the material, which includes attending to important aspects of the presented material, mentally organizing it into a coherent cognitive structure, and integrating it with relevant existing knowledge” (p. 43). Three assumptions form the basis of CLT: the dual channel assumption, the limited capacity assumption, and the active processing assumption. The dual channel assumption is drawn from Paivio’s (1983, 1990) dual-coding theory that includes the articulatory loop and the visuospatial sketchpad (a.k.a., verbal and visual information processing channels). According to the dual channel assumption, humans have separate information processing channels for verbal and visual materials. The limited capacity assumption is drawn from Baddeley’s (1986, 2001) and Cowan’s (2001) working memory theories. According to the limited processing assumption, there exists a limited processing capacity in the verbal and visual channels. The active processing assumption characterizes learning as requiring substantial cognitive processing in the verbal and visual channels. The active processing assumption is drawn from Wittrock's (1989) generative-learning theory and Mayer's (1999, 2002) selecting-organizing-integrating active learning theory.

Cognitive load theory distinguishes between three types of cognitive load. The terminology to describe each of the three types vary between Mayer and the cognitive load theorists within Sweller's sphere of influence, such as Paas, van Merrienboer, and Kalyuga; however, the differences are slight. In Table 3 below, the types of cognitive load processing, which follow the two researcher orientations, Mayer and Sweller, are presented with a brief description.

Table 3

Types of cognitive load processing with researcher's title differences

Processing Type (Mayer)	Description (Mayer & Moreno, 2003)	Processing Type (Sweller)	Description (Feldon, 2007)
Representational Holding	Representational holding refers to cognitive processes aimed at holding a mental representation in working memory over a period of time.	Intrinsic	Intrinsic cognitive load represents the burden to working memory inherent in the semantic content required for a particular task.
Essential	Essential processing refers to cognitive processes that are required for making sense of the presented material.	Germane	Germane load is the minimum level of cognitive load necessary for effective instruction (intrinsic load plus unavoidable extraneous load imposed by pertinent situational constraints).
Incidental	Incidental processing refers to cognitive processes that are not required for making sense of the presented material but are primed by the design of the learning task.	Extraneous	Extraneous load represents unnecessary structural or semantic content that occupies space in working memory (i.e., an external or internal distraction).

The key concept behind representational holding and intrinsic cognitive load is realizing there is a balance between the limited capacity of working memory and the semantic requirements necessary for understanding. For learning or cognitive processing to occur, there is a point where the semantic requirements are irreducible, which means that the learner must draw from existing schemata in long-term memory or create new schemata. This processing takes place within the limited capacity of working memory of about four chunks. Processing for an experienced learner will proceed more efficiently than for the novice as the chunks entail more associated schemata (see the dual processing theory and expertise described earlier). Mayer's example of representational holding is the case of an illustration being presented in one computer screen window and the textual description of it residing in another. To process the description, a learner must hold a representation of the graphic in working memory while processing the semantics of the text, or the reverse of holding the semantics in working memory while viewing the graphic.

The main idea of essential or germane cognitive load, as different from representational holding or intrinsic load, is the level of processing required to learn the targeted material. Whereas representational holding or intrinsic load refers to capacity limits for irreducible semantic content, essential or germane load refers to the processing requirements necessary for new material, where *new* can be said to refer to the lack of pre-existing schemata in a student. Mayer's example is to describe a student making sense of presented material: if the material includes unfamiliar terms or concepts, while making use of images or sounds, the student must select, organize, and integrate all or most of the presented material for effective learning to take place. An important distinction is that there exists no unnecessary presentation of material – nothing is superfluous.

The main idea of incidental or extraneous cognitive load is the presentation of unnecessary material that is not required to learn the targeted material. When the material presented is a distraction from learning what is necessary, the processing that occurs to manage it is considered incidental or extraneous.

The impact of cognitive load on instructional design is significant in three ways. For the first, the three types of load are additive (Mayer & Moreno, 2003; Sweller, van Merrienboer, & Paas, 1998). As a designer builds instruction, attention must be made to the amount of processing that will take place to manage the material since all types of load will be added and cognitive overload becomes possible. However, given that processing is divided into verbal and visual channels, there is the possibility of *load balancing* to improve overload management. For the second, the theory permits development of instructional design principles to manage the variety of forms and situations that create load. Clark and Mayer (2007) provide some examples of principles derived from cognitive load theory that include (a) the multimedia principle to support text and graphics use; (b) the contiguity principle to align words to corresponding graphics; (c) the modality principle to present words as audio narration rather than as on-screen text only; (d) the redundancy principle to explain visuals with words in audio or text but not in both; (e) the coherence principle to manage the addition of interesting material that can hurt learning; (f) the personalization principle where conversational styles and virtual coaches are used in place of more formal delivery styles; and (g) the segmenting and pre-training principle to manage topic complexity, which is similar to Reigeluth's Elaboration Theory (1999; see also Reigeluth, 1979; Reigeluth & Darwazeh, 1982). For the third, it is critical to remember that learning is an individual journey: schemata will vary between individuals, so it is a given that some material will be perceived as incidental or extraneous load for some individuals, while the same material can be considered germane load for others. This consideration implies that cognitive load theory and its derivative principles are more guidelines for practice than absolutes.

Cognitive Load Theory and Instructional Design: Should Load Be Avoided?

It has been treated elsewhere within this chapter that instructional designers today work within complex environments that can include online learning or ALN infrastructures, as well as using a multitude of multimedia content to support instructional delivery. The impact of cognitive load theory within this environment should be significant, as instructional designers and instructors work to consider the mental effort and cognitive load they will induce on students as they work through a course. The scenario increases the complexity with the addition of ALN environments. A feedback mechanism from students becomes necessary for an instructor to determine the full impact of cognitive load created by instructional content and design: when the instructor is not within the vicinity of the learner, either temporally or spatially, an instructor's correction is delayed, and we face the possibility Clark (1999) warned us that the experience can damage learning. However, it is difficult to find in the literature any mention whether cognitive overload is always something to avoid. Anecdotal evidence would suggest that overload occurs regularly, and yet some individuals manage it by developing their own strategies, as might be inferred by successful college careers. It is entirely possible that some forms of cognitive overload may fall into a category of being a motivator, quite similar to presenting a challenge, which some learners may find attractive. This would partially explain findings by Capan, Lambert, and Kalyuga (2009) on the ambiguous nature of the relationship between mental effort and actual cognitive load: "…low mental effort could be the result of low cognitive load or simply a lack of interest or engagement in activity" (p. 156) versus "…students placed greater values on more challenging topics or activities…" (p. 160). While cognitive load and its management are important, it remains unclear whether cognitive overload is always a situation to avoid. Without a more clear understanding of the relationship between satisfaction and cognitive load, the field and practice of instructional design are missing an important element.

Measuring Cognitive Load

It would be useful to know, and more useful to predict, with a reasonable level of accuracy, how much cognitive load might be induced with a particular instructional design. Similar to efforts researching and measuring satisfaction, there are a number of methods that have been used in efforts to measure cognitive load, and they fall into the classification of *direct* or *indirect* measurement methods. Direct measurement methods remove the subjective element from the procedure. The difference between the two methods is in the use of techniques that are *objective* for the former, such as physiological parameters, and *subjective* for the latter, such as self-rating scales.

The literature includes several reports on research efforts to use direct or indirect measurement methods on cognitive load. Paas and van Merrienboer (1994) report using both and found that the subject, self-rating approach met the requirements to be useful in instructional design research. The direct measurement technique the researchers used included papillary diameter, heart-rate variability, and event-related brain potentials. The indirect measurement technique the researchers used were rating scales to report the expenditure of effort or capacity experienced. The rating scale was a modified version of Bratfisch, Borg, and Dornic's scale (1972) that measures perceived task difficulty on a nine point scale ranging from 1, being very, very easy to 9, being very, very difficult. For the direct measurement technique, the researchers performed a spectral analysis of heart-rate variability. The idea behind such a technique is that the heart-rate will change during a load scenario, and the spectral analysis technique provides a mathematical method for finding and analyzing changes to periodic components. Paas and van

Merrienboer (1994) found the rating scale to be high regarding reliability and sensitivity, whereas they found the spectral-analysis technique to be low in reliability and sensitivity. The researchers argue that there is a chance that the psychophysiological measurement techniques could have been measuring both relevant (to the experimental circumstance the research was set to measure) and irrelevant cognitive processes. The researchers conclude that further investigation is warranted.

Brunken, Plass, and Leutner (2003) also report on techniques to measure cognitive load. However, these researchers further refine the technique distinctions by allowing for four categories of techniques: (a) indirect-subjective, such as the self-report scale used by Paas and van Merrienboer (1994) that was a post-treatment questionnaire; (b) direct-subjective, such as a material difficulty rating scale used by Kalyuga, Chandler, and Sweller (1999); (c) indirect-objective, which can be measured by analyzing performance outcomes; and (d) direct-objective, such as using positron-emission tomography (PET) and functional magnetic resonance imaging (fMRI) to measure brain activation during a task. Brunken et al. note that the downside of the direct-objective techniques are that (a) the connection between memory load and prefrontal cortex activity is not yet well understood, and (b) there are technical complexities inherent that make using the strategies impractical for authentic learning situations. Brunken et al. instead argue for and tested another direct-objective technique: the *dual-task-paradigm*. The dual-task-paradigm is well known within experimental psychology and is based on the assumption of limited resources that can be easily allocated to task solving. The technique employs two tasks specifically designed to induce load. By increasing load on a subtask, the effect on cognitive processing on a primary task can be studied. In their study, Brunken et al. found that learner engagement increased when the task was easy or moderately difficult, but that it decreased when the task was difficult and the load was high. The noted downsides to the technique of using dual-task-paradigm are (a) there is a dependency on the sensory modality of the information, which can affect the measurement (e.g., if the secondary task is using a different modality than the primary task ,thereby permitting more effective processing than if both secondary and primary are using the same channel); and (b) the use of reaction time measurements requires a within-subjects experimental design, which can be problematic as research has shown that cognitive load varies significantly among learners (Brunken et al., 2003).

Rubio, Díaz, Martín, and Puente (2004) reviewed several instruments that use subjective techniques to measure mental work load and reported on multiple dimensions for each tool:

1. Sensitivity: power to detect changes in task difficulty or demands.
2. Diagnosticity: being able to identify changes to workload variation and the reason for the changes.
3. Selectivity/Validity: being sensitive to cognitive demands, as well as physical workload, emotional stress, and mental workload.
4. Intrusiveness: the degree to which measurement interferes with task performance.
5. Reliability: consistently reflecting mental workload.
6. The implementation requirements: determining other factors that influence a tool’s utility, such as time, nature of the instruments, and data collection and analysis requirements.
7. Subject acceptability: the subject’s perception of the usefulness and validity of the procedure.

The instruments studied were the Subjective Workload Assessment Technique (SWAT), NASA Task Load Index (TLX), and the Workload Profile (WP). The methods these instruments follow are task focused and time consuming. The SWAT technique uses a subjective rating technique with three levels: low, medium, and high on each of three dimensions: time load, mental effort load, and psychological stress load. SWAT produces a single, global rating scale with interval properties by using a conjoint measurement and scaling technique. The NASA-TLX technique uses six dimensions to assess mental workload: mental demand, physical demand, temporal demand, performance, effort, and frustration. A scale with twenty bipolar steps is used to produce ratings for each dimension. The WP technique uses nine dimensions to assess mental workload: perceptual/central processing, response selection and execution, spatial processing, verbal processing, visual processing, auditory processing, manual output, and speech output. Subjects rate each area for each task as a percentage of what mental processing that aspect consumed to complete the task. The NASA-TLX and WP techniques required 60 minutes to administer, while SWAT required 70 minutes. Subjects found difficulties comprehending the dimensions of WP, and the ranking task in SWAT proved wearisome. Rubio et al. conclude with the recommendation that if the goal is to compare mental workload between two or more tasks, then use WP. If the goal is to predict performance for a particular individual in a task, then NASA-TLX is best. If an analysis of cognitive demands or attention resources is the goal, then either WP or SWAT will be best. However, given the complexity of the instruments and the time requirement to administer any of these techniques is great, their utility for efficiently determining an estimate of cognitive load is questionable.

While direct measurement techniques that present a more objective presentation of results is appealing, the practicality of such techniques is not always high. A few researchers examining aspects of cognitive load assert the utility of self-report methods, as long as the subjects are not being asked to rate the factors affecting decisions (Paas, Tuovinen, Tabbers, van Gerven, &

Pascal, 2003; Paas & van Merrienboer, 1994; Salomon, 1983, 1984). Further, Paas, Tuovinen, van Merrienboer, and Aubteen Darabi (2005) argue for the importance of shifting the focus from non-authentic laboratory experiments to authentic e-learning environments. Supporting this shift, researchers will need to employ techniques and instruments that are not intrusive, such as neurophysiological PET or fMRI, as well as carefully considering possible results from techniques that may be time consuming, such as the Subjective Workload Assessment Technique (SWAT) or Workload Profile (WP). Still, self-report rating methods remain the most efficient technique for consideration.

Connecting Satisfaction to Cognitive Load

In this final section before the chapter summary, work by Mayer and Moreno are reviewed as they present an opportunity to target studies on cognitive load. A framework to include the context of learning through ALN is presented, followed by a strategy to target cognitive load. Finally, a theoretical framework for studying student satisfaction and cognitive load in online learning is presented with a brief discussion.

Cognitive Load Scenarios

From the results of a 12-year program of research, Mayer and Moreno (2003) present five different scenarios that involve cognitive overload in multimedia learning. The five scenarios represent the most common cognitive overload situations as a mix between the three types of processing. In Table 4 below, the five scenarios are presented with the context of the load type terms used by researchers following Sweller’s conventions.

Table 4
Five cognitive overload scenarios (Mayer & Moreno, 2003) with cognitive load processing types (Pass, Renkl, & Sweller, 2003)

Mayer Overload Type	Mayer Overload Scenario	Processing Type (Mayer: M; Sweller: S)
Type 1: Essential processing in visual channel > cognitive capacity of visual channel	Visual channel is overloaded by essential processing demands.	M: Essential S: Germane (visual overload only)
Type 2: Essential processing (in both channels) > cognitive capacity	Both channels are overloaded by essential processing demands.	M: Essential S: Germane (auditory + visual overload)
Type 3: Essential processing + incidental processing (caused by extraneous material)> cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to extraneous material).	M: Essential + Incidental S: Germane + Extraneous (auditory + visual, auditory or visual overloads)
Type 4: Essential processing + incidental processing (caused by confusing presentation) > cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to confusing presentation of essential material).	M: Essential + Incidental S: Germane + Extraneous overloads
Type 5: Essential processing + representational holding > cognitive capacity	One or both channels overloaded by essential processing and representational holding.	M: Essential + Representational Holding S: Germane + Intrinsic overload

Table adapted from "Nine ways to reduce cognitive load in multimedia learning," by R. E. Mayer, and R. Moreno, 2003, Educational Psychologist, 38(1), p. 46.

The five scenarios represent an authentic context of cognitive overload. From this perspective, Mayer and Moreno suggest five situations where researchers might expect to find cognitive overload. Based on the dual-channel assumption and a variety of mixes where an individual might face different load types as processing capacity is exceeded, this work presents a unique opportunity to study a variety of situations that might reflect the mental effort students experience as they process multimedia or ALN delivered instructional materials. In the type one scenario, students are processing visual content that may be too much, such as when a student is watching an animation while following concurrent text describing what is taking place in the animation. In the type two scenario, students cannot process quickly enough the combination of visual or auditory information, such as when an animation presents concepts with explanatory text at a rate that is too quick. This is similar to face-to-face instruction where an instructor presents material on a classroom white board with associated text at a rate that is too fast for students to follow. In the type three scenario, students are faced with one or both channels being overloaded due to the processing of essential and non-essential information. In scenario type three, a student might be working to learn material, while being distracted with instructional content that is not directly relevant to primary learning objective. In the type four scenario, the learning task reflects a similar situation to type three, but the cause of the overload is different. Instead of having to process material that is extraneous, the student is processing material that is presented in a confusing way, such as when explanatory text is not presented in close enough proximity with the object it is describing (e.g., the legend to a graphic is not placed where the graphic is). In the type five scenario, a student is required to hold too much information in memory while trying to integrate new material. In this situation, the cognitive capacity is not enough to process the new information since capacity is reached by holding pertinent and necessary information for understanding.

One value these scenarios provide is a means to describe situations students might find recognizable within their instructional experiences. As these scenarios reflect reasonable opportunities that cognitive load is exceeded, then it becomes possible to use the scenarios to study students when they face managing mental effort to reach instructional goals. The scenarios represent an opportunity to reverse the thinking by considering that a particular scenario can be evidence of cognitive load, whether that load is managed or overloaded, and as such the scenarios become a tool to have students self-report on their experience.

Satisfaction Variables & Cognitive Load Scenarios

Satisfaction, as has been discussed, is multi-faceted due to the many influences that play a role in its development. Satisfaction will be tied to the context of learning that will span the dimensions students perceive as having primary importance. The eight dimensions that comprise the Sloan Model reflect a useful framework from which to derive the contextual perspective that students within ALN environments find critical. The five scenarios that comprise the Mayer and Moreno research reflect a useful framework from which to derive situations where mental effort might be significant or overloaded. Inquiries into a student's reaction to cognitive load can be made within context of the ALN environment to study a possible relationship between cognitive load and satisfaction.

Derived from the discussion within this chapter to identify a means to study student satisfaction in online learning environments, Figure 5 below presents a conceptual model that summarizes the theoretical framework to be used in this study, the constructs employed to study relationships, and the general connections to instructional design concerns.

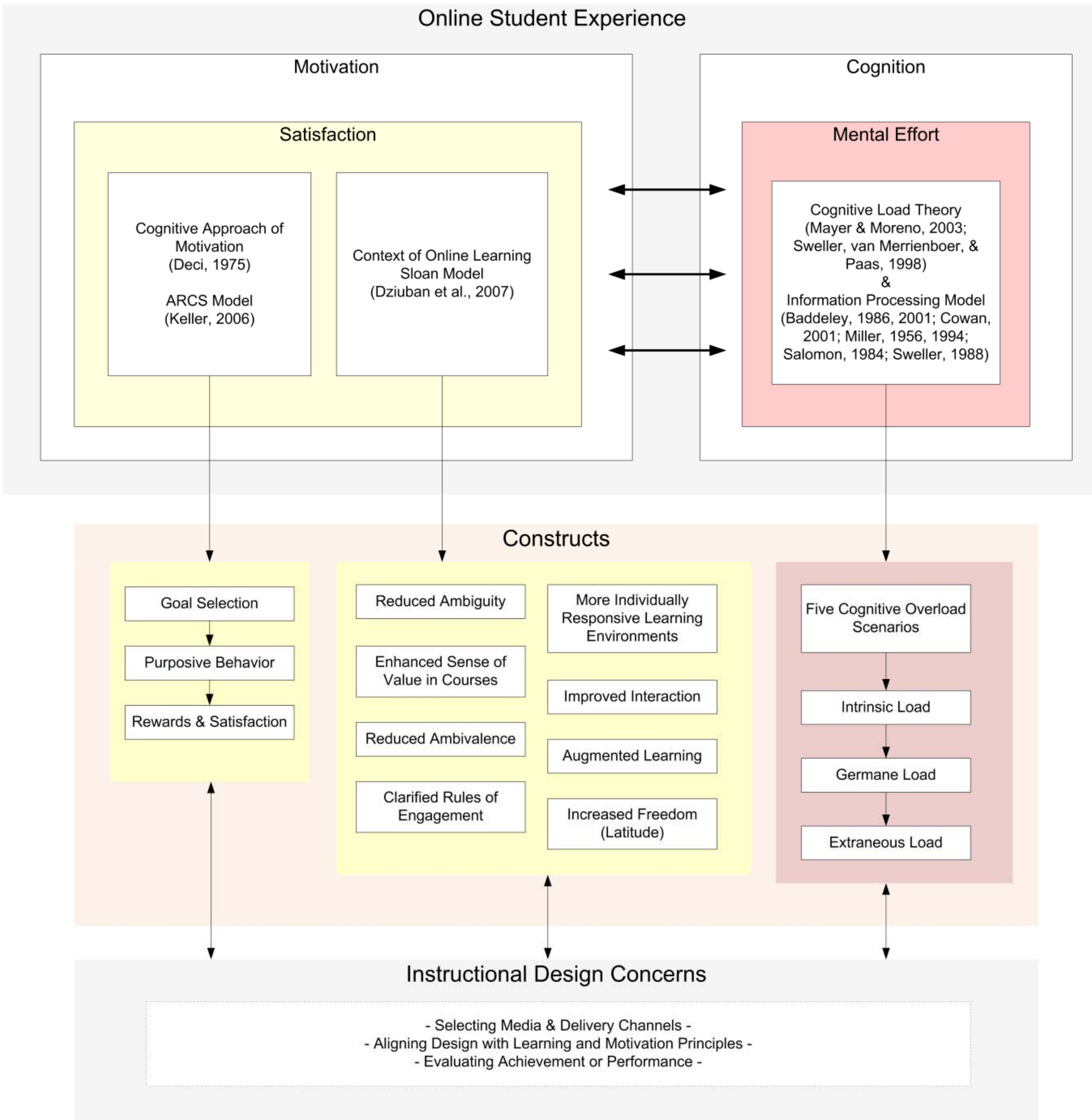

Figure 5. A conceptual framework of key theoretical and empirical foundations used to study student satisfaction in online learning.

The three major components of the conceptual model present the theoretical frameworks that provide direction for the study: (a) cognitive approach of motivation and the ARCS model; (b) context of online learning and the Sloan model; and (c) cognitive load theory and two leading research works in the field. Keller's ARCS model is well-tested and researched and provides a systematic approach for analyzing and integrating motivation within instruction. Since this study focuses specifically on satisfaction, Deci's Cognitive Approach of Motivation is used to target satisfaction within the larger framework of motivation. As discussed previously in this chapter, satisfaction is summative, but it also functions in a forward looking feedback loop, which further guides behavior and goal selection. Deci's conceptualization provides the connection of satisfaction to performance. The Sloan Model by Dziuban et al. (2007) provides dimensions that describe aspects of online (ALN) learning, as well as a process that can contribute the particular components within each dimension. The Sloan Model elegantly provides a means to capture data on a complex construct. The cognitive load theory component taps two major works: the architecture of cognitive load theory by Sweller and van Merrienboer (1998) and the empirical research by Mayer and Moreno (2003). On the one hand, the Sweller and van Merrienboer work provides the background detail of the theory base, while the Mayer and Moreno work provides an opportunity to target realistic scenarios that can be identified within actual course delivery ALNs for study purposes. This theoretical framework will be used in the following chapter to guide the development of research strategies and methods to explore whether or not a relationship exists between student satisfaction with online learning and cognitive load.

Chapter Summary

Summary

While leaders in the field of instructional technology assert a positive relationship exists between motivation, mental effort, and performance, research has yet to explain the nature of this relationship. Research efforts on cognitive load, as an index of mental effort, have not yet explored whether overload from multimedia or ALN delivery strategies have any effect on student satisfaction. The direction from cognitive load theory suggests using instructional design techniques to mitigate cognitive overload resulting from multimedia or other ALN delivery strategies, but these directions do not address motivation since a relationship between cognitive load and satisfaction is unknown.

The specific focus of this review of the literature is the question of whether learner satisfaction with online learning is influenced by cognitive load. Part of the study purpose is to find a means to identify cognitive load, detail the context of ALN learning, and explore learner satisfaction as influenced by cognitive load within the ALN context. Course evaluation methods, especially the Kirkpatrick Four Level Model, are explored and found to be problematic as evidenced by the lack of understanding of any relationship between mental effort and satisfaction.

From a philosophic overview, the point is argued that the practice of instructional design should subordinate the value of the instructional delivery mechanism to the direct concerns that focus instructional design, which is the achievement of instructional objectives through careful and deliberate application of strategies that follow accepted or proven learning and teaching principles. However, the evidence is significant that instructional design practitioners should be concerned with the media selection and implementation choices of multimedia or ALN components. Following grounded learning theories and motivation principles should improve the quality of instructional design, but these guidelines should also consider existing technical infrastructures that may reflect the situational context of instruction and learning. The argument made is that alignment and implementation of learning and motivation principles will need to consider the affordances of any ALN technical features or other technologies that may be part of a pre-existing delivery infrastructure.

The works of Volet and Cole and Engeström are considered to suggest that learner engagement and levels of effort are shaped by multiple influences that lie beyond the immediate, proximal, learning context. From this perspective, a model to study student satisfaction will need to include the immediate learning context, as well to some degree the wider, socio-cultural (or situative) conditions. Therefore, to prove useful as a construct to inform instructors and instructional designers, satisfaction should include aspects of the learning context. The Sloan Model, described as both structure and process, is explored as a potential approach to capture the learning context of learners engaged in an ALN infrastructure.

Parts of information processing theory are explored as this informs cognitive load theory. Some important principles from information processing theory that impact learning are discussed, including working memory, chunking, the visual or auditory processing channels (i.e., the dual-channel theory) and dual processing theory that accounts for differences in expertise on learning. Novices without schemata cannot process information as effortlessly as those with experience since their lack of conceptual framework makes cognitive processing less efficient than an expert's. As cognitive processing demands increase to manage novel declarative information and range beyond a learner's existing schemata, the more the processing must be conscious, deliberate, and constrained by limits of working memory.

The impact of cognitive load on instructional design is significant in three ways. For the first, the three types of load are additive. For the second, the theory permits development of instructional design principles to manage the variety of forms and situations that create load. For the third, it is critical to remember that learning is an individual's journey: schemata will vary between individuals, so it is a given that some material will be perceived as incidental or extraneous load for some, while the same material will be considered germane load for others. This consideration implies that implemented cognitive load theory and its derivative principles are more guidelines than absolutes when applied to the practice of designing instruction for many learners studying through ALNs. Yet while cognitive load and its management are important, it remains unclear whether cognitive overload is always a situation to avoid. Without a more clear understanding of the relationship between satisfaction and cognitive load, it is asserted that the field and practice of instructional design are missing an important understanding.

Paas, Tuovinen, van Merrienboer, and Aubteen Darabi (2005) argue for the importance of shifting the focus from non-authentic laboratory experiments to authentic e-learning environments. Supporting this shift, researchers exploring cognitive load will need to employ techniques and instruments that are not intrusive, such as neurophysiological PET or fMRI, as well as carefully considering possible results from techniques that may be time consuming, such as Subjective Workload Assessment Technique (SWAT) or Workload Profile (WP). Still, self-report rating methods remain the most efficient technique for research studies.

Five cognitive overload scenarios are identified by Mayer and Moreno (2003) as a result of a 12 year program of research. One value these scenarios provide is a means to describe situations students might find recognizable within current instructional experiences. As these scenarios reflect reasonable opportunities that cognitive load is exceeded, then it becomes possible to use the scenarios to study students when they face managing mental effort to reach instructional goals. By considering that a particular scenario can be evidence of cognitive load, whether that load is managed or overloaded, the scenarios become a tool to have students self-report on their experience.

The components of the learning context that students find important need to be part of studying student satisfaction. The eight dimensions that comprise the Sloan Model reflect a useful framework from which to derive the contextual perspective that students within ALN environments find critical. Further, the five scenarios that comprise the Mayer and Moreno research reflect a useful framework from which to derive situations where mental effort might be significant or overloaded. Inquiries into a student's reaction to cognitive load can be made within context of the ALN environment to study a possible relationship between cognitive load and satisfaction. The theoretical framework that forms the basis of this study is presented as a conceptual model at the conclusion of the chapter.

Bridge to Next Chapter

Next, in chapter 3, the methods of data collection and analysis are presented.

CHAPTER THREE: METHODS

In this chapter, methods used to investigate the relationship between cognitive load and student satisfaction with learning online are discussed. This chapter includes five major sections: (a) operational definitions; (b) instrument development; (c) data collection, analysis, and findings: pilot; (d) data collection: final; and (e) data analysis: final.

The first section, *operational definitions*, presents a list of concepts treated within the study that were not specifically addressed in chapter one, *Introduction*. There are no subsections to *operational definitions*.

Section two, *instrument development*, includes three subsections: (a) context of online learning survey items; (b) demographic survey items; (c) target survey audience.

Section three, *data collection, analysis, and findings: pilot*, includes three subsections: (a) faculty related instrument concerns; (b) review of pilot data; and (c) corrections to final instrument.

Section four, *data collection: final*, includes two subsections: (a) revised instrument details: cognitive load; and (b) revised instrument details: context of learning online.

Section five, *data analysis: final*, includes three subsections: (a) faculty recruitment and data preparation; (b) data analysis procedures: overview and discussion; and (c) summary analytic procedures.

The final section includes the summary with a bridge to the next chapter.

Operational Definitions

The following operational definitions relate to the concepts employed within this study.

1. Asynchronous Learning Networks (ALNs): Distributed instructional delivery systems whereby the preponderance of activity between students and instructor is asynchronous, which are Web-only and Mixed-mode type courses (Dziuban, Moskal, Brophy-Ellison, & Shea, 2007).
2. Cognitive Approach to Motivation: "…assumes that people decide what to do on the basis of their evaluations of the likely outcomes of their behavioral alternatives. Then they behave in accordance with their decisions"; "…that behavior can initially be engaged in voluntarily as a result of the processing of information which one has in his memory and in his cognitive representation of the environment" (Deci, 1975, p. 15). People set goals and select behavior to achieve those goals, which they believe will satisfy their needs.
3. Cognitive Load or Mental Effort: "The load imposed on working memory by information being presented" (Mayer, 2005, p. 28). Cognitive load can be said to be the non-automatic mental elaborations applied to information processing or learning (Clark, 1999; Feldon, 2007; Salomon, 1983, 1984).
4. Cognitive Load Theory: "An instructional theory based on our knowledge of human cognitive architecture that specifically addresses the limitations of working memory" (Mayer, 2005, p. 28). The theory seeks to clarify the cognitive processing differences between novices and experts (Feldon, 2007a; Paas, Renkl, & Sweller, 2003a, 2003b; Sweller, 1998; Salomon, 1984). The theoretical framework includes a categorization of three types of cognitive load: representational holding (or *intrinsic*), incidental (or *extraneous*), and essential (or *germane*) (Mayer and Moreno, 2003; Pass, Renkl, and Sweller, 2003a). The duplication of terms for each

load type is the following: Mayer and Moreno (2003) – outside of parentheses; and Pass, Renkl, and Sweller (2003) – within parentheses. Deriving student perceptions for each of the three categories define their cognitive load for a course.

5. Learning: “Any change in long-term memory involving an accumulation of information” (Mayer, 2005, p. 29).
6. Motive: “…affectively toned associative networks arranged in a hierarchy of strength or importance within an individual” (McClelland, 1965, p. 322). “Behavior is motivated when some cue redintegrates an affective situation” (Deci, 1975, p. 14).
7. Multimedia: “Presenting words (such as printed text or spoken text) and pictures (such as illustrations, photos, animation, or video)” (Mayer, 2005, p. 2).
8. Multimedia instruction: “Presenting words and pictures that are intended to promote learning” (Mayer, 2005, p. 2).
9. Multimedia learning: “Building mental representations from words and pictures” (Mayer, 2005, p. 2).
10. Online learning or learning online: Used interchangeably with Asynchronous Learning Network (ALN).
11. Satisfaction: Satisfaction refers to a range of feelings, from positive to negative, about a learner’s accomplishments and learning experiences. These feelings are intrinsic in the individual learner, are associated with an outcome that is perceived by the individual to be fair, and are influenced by extrinsic rewards (i.e., the situative learning context) (Dubuc, 2009; Deci, 1975). Satisfaction functions as a feedback loop with an awareness of potential satisfaction associated to particular

behavior as extrinsic motivation, and as a feedback loop that supports intrinsic motivation (Deci, 1975, p. 122; see also Deci, 1975 pp. 98-99, Figure 6 – a cognitive approach to behavior).

12. Working Memory: "The cognitive structure in which we consciously process information. Notable for its severe capacity and duration limits when dealing with new information" (Mayer, 2005, p. 29).

Instrument Development

This research study examines the relationship between cognitive load and satisfaction, and represents a new direction in the field of cognitive load theory and motivation theory research. There are several indirect measurement instruments designed to work with cognitive load, but these instruments – Subjective Workload Assessment Technique (SWAT), NASA Task Load Index (TLX), and the Workload Profile (WP) (Rubio, Díaz, Martín, & Puente, 2004) – are task focused, and not designed to incorporate satisfaction. Therefore, for the purposes of this study, a new instrument was developed. The development and pilot of the instrument reflect phase 1 activities. The final instrument was the outcome of phase 1. Phase 2 activities include analysis of the data collected using quantitative techniques. The outcomes of phase 2 constitute the study findings.

Cognitive Load Survey Items

Data collection used a questionnaire delivered online and included questions regarding students' reaction to perceived cognitive load in fulfillment of course objectives. The items in the questionnaire were developed following guidelines on cognitive load theory.

In their article, Mayer and Moreno (2003) identify and define three types of cognitive processing: (a) essential, which is the mental effort invoked to make sense of incoming stimuli;

(b) incidental, which is mental effort expended unnecessarily, as its value or contribution to make sense of incoming stimuli is low; and (c) representational holding, which is mental effort expended to hold verbal or visual representations in working memory. Pass, Renkl, and Sweller (2003a) refer to these three types as (a) germane, (b) extraneous, and (c) intrinsic. Representational holding (or intrinsic processing) describes the cognitive process that takes place for any new learning and can be viewed as the innate complexity the learning presents an individual. Essential processing (or germane processing) describes the scaffolding acquired from previous experience, delivered through instructional design, or experienced from a teacher's presentation, which facilitates processing the representational holding. Incidental processing (or extraneous processing) describes incidental, unnecessary processing that is non-critical for the targeted learning. These three processing types have an additive relationship with each other. The additive relationship translates to the possibility of overload if efforts are not made to reduce or remove incidental processing and improve the instructional design to streamline essential processing. Instructional manipulations can redistribute the load acquired as part of representational holding (Mayer & Moreno, 2003), which is not a viewpoint held by Pass, Renkl, and Sweller (2003a) who maintain that instructional manipulations cannot change intrinsic load. In the context of this study, the point of distinction carries no consequence: the need discussed here is to identify and react to instances of overload, not present remediation for found instances.

An inherent challenge in attempting to measure cognitive load is the variability among individuals. Brunken, Plass, and Leutner (2003) concede that within-subject study designs may be the only alternative because one student can perceive germane load, whereas another perceives extraneous load. However, if students are asked to self-reflect on common instances representative of a cognitive overload, then a researcher essentially uses the instances, or scenarios, as a means to make possible between-subjects studies. This sets the learning scenario as a bridge for assessing reaction (i.e., satisfaction) to mental effort. Surveys are used to sample populations to explore the incidence, distribution, and interrelationships among sociological, psychological, and educational variables (Ary, Jacobs, & Razavieh, 1990; Kerlinger, 1979). Given that this study explores a relationship between psychological variables on a sample population, using the survey as a research method was indicated. Further, using scenarios as a mechanism for sampled individuals to self-assess allows a between-subjects design to be possible within a survey, while retaining individual variability.

From 12 years of empirical research, Mayer and Moreno (2003) present five cognitive overload scenarios, which they represent as *overload types*. In Table 5, *Phase Cognitive Load Survey Items Based on Mayer & Moreno (2003) & Pass, Renkl, & Sweller (2003)*, the five overload types are presented together with this researcher's developed statement items used in the pilot survey. Two statements were developed to match each of the five overload types described by Mayer and Moreno (2003). Each statement was set in a five-point Likert scale to range from *Strongly Agree* to *Strongly Disagree*. The midpoint was *Neutral*. A respondent's positive response to statement items was considered as evidence this type of cognitive overload is perceived as having occurred within the participant's asynchronous, online course. A respondent's negative response indicated no overload was perceived.

Table 5

Phase 1 Cognitive Load Survey Items Based on Mayer & Moreno (2003) & Pass, Renkl, & Sweller (2003)

Mayer Overload Type	Mayer Overload Scenario	Instrument Items	
Type 1: Essential processing in visual channel > cognitive capacity of visual channel	Visual channel is overloaded by essential processing demands.	1	The instructor relied heavily on visual materials.
		2	More material should be presented in an audio format (e.g., verbal recordings).
Type 2: Essential processing (in both channels) > cognitive capacity	Both channels are overloaded by essential processing demands.	3	I think the use of audio in this course was excessive.
		4	I think the use of text-based materials in this course was excessive.
Type 3: Essential processing + incidental processing (caused by extraneous material)> cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to extraneous material).	5	The instructor used material in this online course that I did not think was relevant to understanding critical concepts.
		6	In some instances, critical information was presented as multimedia when a simple text document would have been better.
Type 4: Essential processing + incidental processing (caused by confusing presentation) > cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to confusing presentation of essential material).	7	I could not understand how to use some material that was included in this online course.
		8	I found that information critical for understanding key concepts was located in many different places.
Type 5: Essential processing + representational holding > cognitive capacity	One or both channels overloaded by essential processing and representational holding.	9	I believe that to learn this material successfully, I must work with a large number of facts and concepts.
		10	I believe that I am able to retain a large number of facts and concepts.

Table adapted from "Nine ways to reduce cognitive load in multimedia learning," by R. E. Mayer, and R. Moreno, 2003, Educational Psychologist, 38(1), p. 46.

Context of Online Learning Survey Items

In Table 6 following, *Phase 1 Satisfaction Survey Items Based on Sloan Model*, statements are presented as they have been developed to fit within a framework of areas that describe student satisfaction. The framework, titled the Sloan Model (Dziuban, Moskal, Brophy-Ellison, & Shea, 2007; Moskal, Dziuban, & Hartman, 2009), has been theoretically and construct validated to specifically address student satisfaction for asynchronous, online learning. Developing the items for each dimension followed the procedure Dziuban et al. used to create the framework with only a slight modification. Earlier, and within the same research permissions from the IRB board that governs this dissertation, students from a large undergraduate course in psychology were solicited as volunteers to develop statement items for each Sloan Model dimension. The criteria to participate were the same as for this study: students must have been a minimum of 18 years or more, have taken at least one online course, and have granted permission to use the study results. The procedure was conducted completely online, and the student volunteers received a MS Word form that included instructions and the Sloan Model framework with examples (see *Appendix B: Tools to Derive Context*).

The Word form was divided into two parts. Part 1 instructed student volunteers to carefully draft evaluation questions that fall within the eight areas identified in the Sloan Model. Guidelines and examples were provided. Volunteers were instructed to submit at least two question items for each area. In Part 2, student volunteers were instructed to consider themselves as researchers and to submit suggestions or ideas to six prompts regarding the structure and design of the study. Student volunteers were carefully instructed to not include their identity anywhere within the form. Students were instructed to work independently and to complete the form within a limited time and return their work to the researcher through the learning management system. The researcher followed a 10 step protocol (see below) to process student-generated material. This procedure was repeated three times to permit narrowing the statement items in each dimension to two.

The data analysis for the Phase 1 procedure followed these general steps:

1. Extract all original data and organize into a working spreadsheet.
2. Build two worksheets for the purpose of analyzing separately Part 1 and Part 2 of the submitted Word forms.
3. For each original submitted item in each of the two parts, reduce to key words.
4. Build third worksheet for a three step process to merge Part 1 results.
5. Assemble all reduced items according to the eight study areas.
6. Highlight items in each study area that (a) seem to represent the area (b) without being duplicated elsewhere.
7. Review initial results and make further adjustments.
8. Remove items embedded in other results or areas.
9. Rebuild the statements from the resulting elements by (a) reviewing any guidelines provided by the volunteers in part 2 results and (b) reviewing original phrasing (see first worksheet - Data).
10. Make final adjustments to resulting statements with limited re-phrasing allowed: (a) rewrite the statements in the form that student is currently taking an online course and their feedback is solicited; (b) adjust verb tense, so all verbs are in the active and present tense; and (c) edit results again.

Similar to the cognitive load statements, nearly all of the items (numbers 1 – 17 as listed in Table 6 following) of the satisfaction statements were set in a five-point Likert scale, ranging from *Strongly Agree* to *Strongly Disagree*. The midpoint was *Neutral*. Item 18 was an open-ended question for participant free response. The final five items (numbers 19 – 23 as listed in Table 6) were specific satisfaction items that specifically relate to the five Mayer cognitive load scenarios. In the actual instrument, these items were integrated with each of the Mayer cognitive overload types.

Table 6

Phase 1 Satisfaction Survey Items Based on Sloan Model

Sloan Model Satisfaction Areas	Instrument Items	
Area 1: Reducing Ambiguity	1	I found that the syllabus and the assignments clearly indicated what I needed to do in this online course.
	2	I was able to effectively locate answers to my questions about this online course.
Area 2: Enhancing sense of course value	3	I found that I was able to track my progress in the course effectively.
	4	I feel that the instructor's feedback, advice, or guidance in this course was effective.
Area 3: Reducing ambivalence (or improving how the course matters to you)	5	I can see how what I learn in this course is relevant to my major field of study.
	6	I found that I was able to communicate with everyone who was part of this online course effectively.
Area 4: Clarifying engagement or expectations	7	I found that the assessments accurately reflect my level of understanding for the course topics.
	8	I prefer that my instructor have both in person office hours and online office hours, so I can talk about concerns, problems, or grades.
Area 5: Integrating individually responsive learning environments	9	I was motivated to participate in the online activities.
	10	I found that activities following a routine, such as weekly quizzes, readings, or discussions, kept me involved in my online class.
Area 6: Improving interactions	11	I think actively communicating, discussing, or debating is necessary for online courses to achieve maximum effectiveness.
	12	I believe being respectful in online communications is necessary for effective interactions.
Area 7: Augmenting learning	13	I was motivated to go beyond the required assignments in this online course.
	14	For graded assignments, I prefer being able to choose from different assignment options.

Sloan Model Satisfaction Areas	Instrument Items	
Area 8: Increasing freedom (latitude)	15	I felt the course provided enough opportunities for me to develop my own solutions to assignment tasks.
	16	I prefer individually assigned due dates for assignments, rather than an "all due at the end of the semester" approach.
Overall	17	Overall, I am satisfied with this online course.
	18	Please comment on what it takes for you to be satisfied with an online course. (Open-ended.)
Related to Mayer Cognitive Load Type	19	I am satisfied with the instructor's heavy emphasis on visual materials.
	20	I am satisfied with the instructor's heavy use of audio or text-based materials.
	21	I am satisfied with the instructor's selection of material.
	22	I am satisfied with my ability to learn how to use the material included in the course.
	23	I am satisfied with my ability to work in a course where I have to manage a lot of new facts and concepts.

Demographic Survey Items

In addition to survey items covering cognitive load, the context of online learning, and associated satisfaction items, the instrument included items to collect demographic and pilot-specific information. The demographic information collected included the following: (a) age; (b) marital status; (c) academic standing (i.e., freshman, sophomore, junior, senior, graduate, or other); (d) gender; (e) how many children live at home; (f) hours employed (per week); and (g) ethnicity (i.e., African American, Asian Pacific Islander, non-Hispanic White, Hispanic, or Native American). Additionally, inquiries for student experiences with online learning were made: (a) Including courses you are taking this semester, how many blended (M) online courses have you taken?; (b) Including courses you are taking this semester, how many fully online (W) courses have you taken?; (c) What do you find to be the strengths of online courses?; and (d) What do you find to be the weaknesses of online courses?

The pilot specific items to determine general usability of the instrument were set in a five-point Likert scale, ranging from *Strongly Agree* to *Strongly Disagree*, with a mid-point of *Neutral*. The items were set as statements to which students were requested to respond. The items were the following: (a) I found the questionnaire items easy to read; (b) I understood all of the questionnaire items; (c) I did not find any problems with the questionnaire items; and (d) Responding to the items was easy. Finally, an open response item was provided for students to provide commentary on any particular element of the instrument. This last item was the following: "Do you have any suggestions for improving this questionnaire? We will take your suggestions seriously."

Target Survey Audience

Study participants were current college students who stated they have had experience with asynchronous, online courses prior to the term the study was conducted, who were 18 years of age or older, and who agreed to participate in the study. The students were recruited from current online course offerings that were offered as either fully online or mixed mode (blended) courses. Working closely with the Center for Distributed Learning, instructors of the courses were approached to participate in the study. The only effort required of participating faculty was to permit solicitation of student participation through the ALN infrastructure. This researcher developed a solicitation message, delivered through the ALN (see *Appendix C: Student Solicitation Message*), which included a link to an instrument that existed on an independent server. The survey environment that contained the instrument permits multiple access (i.e., a student can save his/her unfinished survey and return later when convenient), while guaranteeing anonymity. Further, the survey environment supports export to statistical analysis packages, such as SPSS which will be used to conduct the final analyses.

Dillman (2006) recognizes instrument pretesting as a "…highly touted part of questionnaire design" (p. 140) and divides this process into the following four sequential stages: (a) review by knowledgeable colleagues; (b) interviews to evaluate cognitive and motivational qualities; (c) conducting a small pilot study; and (d) doing a final check.

These were the steps this researcher took to fulfill Dillman's four step process. Following a review by recognized experts in the design and operationalization of survey instruments, the instrument was pilot tested with a sample of online students. Not only were students asked to respond to the instrument, but they were asked to provide feedback and reflection about the instrument's ease of use and to react to particular items that may have been problematic. A partial analysis was run on the pilot data to determine if there were any issues with the structure of the instrument or if any respondent feedback indicated changes to the instrument were necessary. Traditionally, all findings derived through data analysis are reported in chapter four, *Findings*. However, the findings from the pilot are not intended to reflect results of the study, but rather to identify any potential problems with the instrument prior to final data collection and analysis. Therefore, a formative analysis of the instrument made from the data collection is presented within this chapter, as well as the findings of the pilot are presented. Chapter four presents the analysis of the final data collection. The pilot instrument is presented in *Appendix D: Pilot Survey Instrument*.

Data Collection, Analysis, & Findings: Pilot

From mid-December, 2009, through January, 2010, the pilot instrument was made accessible and student participants were recruited across the university campus. At the end of the pilot data collection cycle, 112 responses were collected. The following is a review of the procedures and results of a preliminary analysis of the pilot data.

Faculty Related Instrument Concerns

Recruiting students to take the survey demonstrated the need to make adjustments to the procedures due to faculty concerns. For the first, some faculty reacted with caution. They expressed concern that the collected data about student experiences could be negatively perceived by their department or college. It became necessary to add a data review and a cleansing step prior to running the data analysis to remove any identifying information that could link responses to particular instructors or courses, as well as ensuring that the original data that holds this information was deleted. The analysis could then be conducted on the "cleaned" data. Adding these two steps to the pre-analysis procedure proved to mitigate faculty concerns, as concerned faculty members elected to participate in the study.

Another issue that several faculty members raised was that bringing the survey into their online course towards the end of the term posed problems. As students were busy with final projects and exams, there was increased likelihood that students elected to not participate. These faculty members suggested that an optimal time would be at some point in the middle of the term. For the pilot design of the instrument, the timing of data collection posed problems since the instrument inquired of students to reflect on actual experiences within the course they were currently enrolled. The earlier in the semester the survey would be run, the less experience the student would have on which to reflect.

Review of Pilot Data

The data from the pilot was downloaded from the website database and scrubbed to remove any identifying information. Following the data scrubbing, original data were deleted. The cleaned data was imported into SPSS (version 16) for an analytic trial run. With the oversight of the dissertation committee chair, the data was analyzed following the procedure that is described in detail in a later section in this chapter to determine if there would be any analytic problems with the final data set.

The analysis revealed that even though 112 respondents participated, the number of data points used to construct the cognitive load scale was far less than expected. In a post hoc analysis, the investigator found that one failing of the pilot instrument was the logic that students were to reflect on whether they *perceived* a load type as defined by Mayer and Moreno (2003). If the students responded with either *Strongly Agree* or *Agree*, then they would be asked to react with a level of satisfaction to the situation. The logic was designed into the instrument that if students answered with anything other than *Strongly Agree* or *Agree* they would never see the satisfaction item. This effectively filtered students from having an opportunity to reflect on their satisfaction with such situations. By reducing the number of data points so drastically, the determination of a relationship became problematic. Therefore the logic component of the instrument required revision. No further analysis was performed on the data.

Regarding the general usability of the pilot instrument, students were asked to respond to four statements, as well as provide comments in an open-ended format. To the first statement, "I found the questionnaire items easy to read," 82% of the respondents either *strongly agreed* or *agreed*. To the second statement, "I understood all of the questionnaire items," 83% of the respondents either *strongly agreed* or *agreed*. To the third statement, "I did not find any problems with the questionnaire items," 79% either *strongly agreed* or *agreed*. And to the fourth statement, "Responding to the items was easy," 82% either *strongly agreed* or *agreed*.

To the open-ended item, most of the responses were generally positive, such as "No I felt the survey was clear and easy to read," or "It was easy to do!"

There were some constructive comments as well, such as:

> "Given the differing natures of M and W courses, perhaps there should be separate surveys for each of these kinds of classes, with the M survey taking into account the integration of the online component with face-to-face instruction, and the W survey addressing the lack thereof."
>
> "The questions asked if I had difficulty with the material. I was unsure if the difficulty was with using the technology that the material was using, i.e., getting a video to work or understanding the concepts presented in the material."
>
> "Not sure why some questions were grouped together (groups of 2 / 3). When combined with the triggered, pop-up, questions, the survey interface was sometimes confusing. Perhaps a visible transition would help the user to understand why these follow up questions appear."
>
> "After having taken so many classes it was hard to choose which one I should use to base my answers to the survey."

The constructive commentary was informative in that the logic used to display items based on student responses can be confusing, as well as the statements themselves. These responses were invaluable to the development of the final instrument.

Corrections to Final Instrument

From the faculty concerns regarding students perceiving issues with their online course designs and the logic that lowers the sample population, the instrument design required adjustments. Since the design of the pilot instrument essentially requested students to reflect whether or not they perceived cognitive load situations similar to the five types described by Mayer and Moreno (2003) and to react to those perceptions, the instrument was dependent upon recognition of a particular situation, which some faculty perceive as potentially problematic. The solution to remedy this problem was to recreate the instrument with hypothetical situations that present the cognitive overload scenarios as described by Mayer and Moreno. This would remove faculty concerns with a potential identification with their course design, as well as to allow the removal of the logic that was dependent upon recognition of the five scenarios. Further, this design approach would allow the instrument to be delivered at any time during a course term, since the situation is hypothetical and not dependent upon current course experience. The changes to the cognitive load and learning context items are fully described forward in this chapter.

Adjusting the instrument to use hypothetical scenarios allowed for the removal of the logic structures that some students found confusing. Rephrasing the statements in such a way as to clarify the cognitive load scenarios addressed the concern one student wrote about knowing whether the statement referred to *technical functionality* or *learning through the technology*. And finally, the rephrased statements set into hypothetical scenarios eliminated the concern one student wrote regarding the difficulty imagining a particular cognitive load situation they had experienced.

Data Collection: Final

Revised Instrument Details: Cognitive Load

In table 7 below, *Phase 2 Cognitive Load Survey Items Based on Mayer & Moreno (2003) & Pass, Renkl, & Sweller (2003)*, the revised structure for the cognitive load items is presented. With this design, the hypothetical situation became the question stem, and the numbered items became statements to which students could respond with a five-point Likert scale ranging from *Strongly Agree* to *Strongly Disagree* with *Neutral* at midpoint. The instrument translated student responses of *Strongly Agree* to *Strongly Disagree* to values 5 to 1 respectively. An empty response was given a zero value. The final item, number 15 was an open-response item for students to enter text commentary.

Table 7
Phase 2 Cognitive Load Survey Items Based on Mayer & Moreno (2003) & Pass, Renkl, & Sweller (2003)

Mayer Overload Type	Mayer Overload Scenario	Instrument items	
Type 1: Essential processing in visual channel > cognitive capacity of visual channel	Visual channel is overloaded by essential processing demands.	Consider the following situation in an online course. The material to learn is difficult, there is a lot of material to learn, and it is all visual (i.e., it is all text or graphics).	
		1	I would be satisfied when the material is only presented in visual formats.
		2	I would be satisfied when some of the visual material is presented instead in an audio format (e.g., verbal recordings).
Type 2: Essential processing (in both channels) > cognitive capacity	Both channels are overloaded by essential processing demands.	Consider the following situation in an online course. The material to learn is difficult, there is a lot of material to learn, and it is all presented with visual (such as using text or graphics) and audio (such as using verbal recordings) materials.	
		3	I would be satisfied when the material is presented in visual and audio formats.
		4	I would be satisfied when the material is presented instead with time between segments.
		5	I would be satisfied when I have had some pre-training to prepare me for the material.

Mayer Overload Type	Mayer Overload Scenario	Instrument items	
Type 3: Essential processing + incidental processing (caused by extraneous material)> cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to extraneous material).	Consider the following situation in an online course. The material to learn is difficult, there is a lot of material to learn, and I find that some of the material is extra, or not really necessary.	
		6	I would be satisfied when the material includes extra content.
		7	I would be satisfied when the extra material is removed.
		8	I would be satisfied when I receive instruction on how to use the extra material.
Type 4: Essential processing + incidental processing (caused by confusing presentation) > cognitive capacity	One or both channels overloaded by essential and incidental processing (attributable to confusing presentation of essential material).	Consider the following situation in an online course. The material to learn is difficult, there is a lot of material to learn, and I find the presentation of the material is confusing (i.e., not the content, but how the content is presented).	
		9	I would be satisfied if the presentation of the material is confusing.
		10	I would be satisfied when visual materials are organized to reduce scanning for corresponding information.
		11	I would be satisfied when duplicated information is removed from the presentation (e.g., when the same information is presented in audio and visual formats).
Type 5: Essential processing + representational holding > cognitive capacity	One or both channels overloaded by essential processing and representational holding.	Consider the following situation in an online course. The material to learn is difficult, there is a lot of material to learn, and I find the material requires I have to keep a lot in my head (i.e., memory) to understand it.	
		12	I would be satisfied if the presentation of the material requires that I keep a lot in memory.
		13	I would be satisfied if the presentation of the material is better organized to reduce having to keep a lot in memory.
		14	I would be satisfied if the presentation of the material requires I keep a lot in memory as long as I am trained to be able to do this.
Open-ended		15	Please describe a situation in an online course when you feel you are overloaded (cognitively) and how you react to it.

Revised Instrument Details: Context of Learning Online

In Table 8 below, *Phase 2 - Context of Online Learning Satisfaction Survey Items Based on Sloan Model (*Dziuban et al., 2007; Moskal et al., 2009), the revised structure for the context of online learning items is presented. With this design, the hypothetical situation became the question stem, and the numbered items became statements to which students could respond with a five-point Likert scale ranging from *Strongly Agree* to *Strongly Disagree* with *Neutral* at midpoint. As in the previous table, the instrument translated student responses to values 5 to 1 respectively. An empty response was given a zero value. The final item, number 18 was an open-response item for students to enter text commentary.

Table 8

Phase 2 Context of Online Learning Satisfaction Survey Items Based on Sloan Model

Sloan Model Satisfaction Areas	Instrument Items	
Situation setup for all questions:		Consider the following situation in an online course and then react to the statements. The material to learn is difficult, there is a lot of material to learn, and I had to put in a lot of effort to learn it.
Area 1: Reducing Ambiguity	1	I find that the syllabus and assignment descriptions must clearly indicate what I need to do for me to be successful in an online course.
	2	I believe that being able to easily find answers to my questions about an online course is critical to my success.
Area 2: Enhancing sense of course value	3	I find it is critical to my success that I am able to track my progress in an online course.
	4	I feel that I require an instructor's feedback, advice, or guidance in an online course to be successful.
Area 3: Reducing ambivalence (or improving how the course matters to you)	5	To be successful, I need to see how what I learn in an online course is relevant to my major field of study.
	6	I need to be able to communicate with everyone who is part of an online course.
Area 4: Clarifying engagement or expectations	7	I find that I need to be assessed (i.e., tested or given feedback) often to know how I am doing in the course.
	8	I prefer that my instructor only has online office hours, where I can communicate my concerns, problems, or grades.
Area 5: Integrating individually responsive learning environments	9	To be successful, I need to be motivated to participate in online course activities.
	10	I need activities that follow a routine, such as weekly quizzes, readings, or discussions, to keep me engaged in my online class.
Area 6: Improving interactions	11	I believe actively communicating, discussing, or debating is necessary for online courses to be effective.
	12	I believe that for interactions to be effective in online communications, it is important to be respectful.
Area 7: Augmenting learning	13	I always want to go beyond the required assignments in an online course.
	14	For graded assignments, I need to have options to be successful in an online course.
Area 8: Increasing freedom (latitude)	15	I feel a course needs to provide me with opportunities to develop my own solutions to assignment tasks.
	16	I need to have assigned due dates through the study term, rather than an "all due at the end of the semester" approach.
Overall	17	Overall, I am generally satisfied when I have to put in a lot of effort to learn.
	18	Please comment on anything else that is important for you to be satisfied with an online course. (Open-ended.)

In Table 9 below, *Phase 2 - Goal Related Components of Online Learning Satisfaction Survey Items Based on Deci (1975)*, the structure related to context of learning for goal related components of online learning items is presented. Specifically addressing awareness of potential satisfaction, goal selection, and purposive behavior was not part of the pilot phase. Emerging from the review of the literature, satisfaction components that are goal related were identified. Elements within these components reflect the learning environment in a similar manner as the elements related to the context of learning (see Table 8) do. These items were added to differentiate from items developed using the Sloan Model and enable analysis of the role of goals in satisfaction. While the goal related items are presented separately from the Sloan Model, they remain an integrated part of the overall construct of satisfaction.

With this design, the hypothetical situation became the question stem, and the numbered items became statements to which students could respond with a five-point Likert scale ranging from *Strongly Agree* to *Strongly Disagree* with *Neutral* at midpoint. As in the previous table, the instrument translated student responses to values 5 to 1 respectively. An empty response was given a zero value.

Table 9

Phase 2 Goal Related Components of Online Learning Satisfaction Survey Items Based on Deci (1975)

Goal Related Satisfaction Areas	Instrument Items	
Situation setup for all questions:		Consider the following situation in an online course and then react to the statements. The material to learn is difficult, there is a lot of material to learn, and I had to put in a lot of effort to learn it.
Area 1: Awareness of Potential Reward	1	I look for the potential of reward when I must learn difficult course material in an online course.
Area 2: Goal Selection	2	I set my goals based on future satisfaction.
Area 3: Purposive Behavior	3	I find that when I am challenged in an online course, satisfaction is its own reward.
	4	I find myself more satisfied when an online course is difficult than when it is not.

The final instrument is presented in *Appendix E: Final Survey Instrument.*

Data Analysis: Final

Faculty Recruitment and Data Preparation

The procedure to preserve complete anonymity as discussed in previous sections was retained for the final data collection prior to analysis. First, any identifying information was removed from the collected data, and second the data in the instrument website database was deleted. This procedure was communicated to prospective faculty to promote support of this research project. Faculty members across the campus were encouraged to participate in the study and the data collection time was limited to four weeks.

Data Analysis Procedures: Overview and Discussion

The final instrument was administered to a sample of 1401 students enrolled in online classes. Once the study data was collected, multiple analysis procedures were completed.

For the purpose of clarifying some the analysis procedures used, this section begins with simple statistical concepts to provide a consistent framework.

$\sum X_{ji}$ will be used to replace the more conventional form: $\sum_{i=1}^{N} X_{ji}$

where *j* may be any one of the *variables* from 1 to N, and *i* may be any one *individual*, also from 1 to N. The sample covariance for any two variables *j* and *k* is

$$s_{jk} = \frac{\sum x_{ji} x_{ki}}{N} . \tag{1}$$

The correlation coefficient is ρ_{jk} and in the sample, Harmon (1968) defined it as

$$r_{jk} = \frac{s_{jk}}{s_j s_k} = \frac{\sum z_{ji} z_{ki}}{N} = \frac{\sum x_{ji} x_{ki}}{\sqrt{\sum x_{ji}^2 \sum x_{ki}^2}} . \tag{2}$$

The analysis techniques this study uses include variance, covariance, and correlation coefficient calculations, as well as Principal Component Analysis (PCA), Image Analysis, and an

Alpha Reliability Analysis. The PCA is a simple eigenvector-based multivariate analysis that can reveal a data set's internal structure. Point representations of a set of variables reflect the loci of uniform frequency density as concentric, similar, and similarly situated ellipsoids, for which the axes correspond to the principal components (Harmon, 1968). PCA involves the rotation of coordinate axes to a different frame of reference that account for the maximum variable variance. The sum of all n principal component variance equals the sum of the original variables' variance. The model for PCA follows:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jn}F_n \quad (j = 1, 2, \cdots, n) \tag{3}$$

where the observed variables, *n*, are described linearly in terms of *n* new, uncorrelated, components $F_1, F_2, \cdots, F_n$ (Harmon, 1968). Harmon also emphasizes that regarding the summarization of data, an important property of the method is that each component "…makes a maximum contribution to the sum of the variances of the *n* variables" (Harmon, 1968, p. 15).

The coordinate axes rotation is a transformation that yields results where the greatest variance lies in the first coordinate (a.k.a., the first principal component), the second greatest variance lies in the second coordinate, and so forth. PCA as a method for analysis makes specific assumptions about the data: (a) the data set is assumed to be linear; (b) the data set must fit the Gaussian assumption of normal distribution; and (c) we assume the most interesting variable are those with greatest variance; thus principal components are to be preferred for study over those with less since they are assumed to be noise. With limitations considered, PCA is useful as a tool to suggest new leads for further research. The inability to predict can arise from multiple sources when the predictors or independent variables are not perfectly related to the criteria or dependent variables. Using the method on the criteria and the predictors can facilitate identifying sources of error (Gorsuch, 1983).

Because rotation is a strategy to find the simplest structures that improve interpretation (Pedhazur & Schmelkin, 1991), and because retaining a realistic view that there can be correlations between variables (Pedhazur & Schmelkin, 1991) is a goal of this study, an oblique rotation method was used to maximize high loadings and minimize low loadings. Oblique rotations have known consequences: the results are less likely to be replicated in future studies due to increased opportunities for sampling errors. However, given the exploratory nature of the study, the optimal strategy was to use an oblique rotation to find a *best fit* for the sample data. The oblique method, Promax Rotation, generates two matrices: pattern and structure. The structure matrix presents factor loadings. The pattern matrix presents the coefficients that represent unique contributions. As the number of factors increases, the general rule is that the number of pattern coefficients will decrease because of the increase in common contributions to variance.

In a study involving multiple variables, some variables may have relationships with others and may be predictable in such circumstances, while others may not have any relationships and be unpredictable. The features that make some variables predictable can be considered the *common parts* of variables. In contrast, the features of variables that leave them unpredictable can be considered the *unique parts* of variables. One known weakness of the factor analysis model is that it cannot provide explicit definitions for the common and unique parts of variables (Mulaik, 1972). Image Analysis, developed by Louis Guttman (1953), is a determinate alternative analysis technique that preserves many features of factor analysis (FA). The common part of the variable is designated the *image*, while the unique part is designated the *anti-image*. Guttman (1955) effectively argued the importance of determinacy when conducting FA by being able to link original variables with any newly discovered factors. Linking variables to factor scores in FA is done by estimating the factor scores for each factor by multiple correlations using the factor-structure matrix (i.e., the matrix that contains the correlations between variables and factors) and the correlation matrix. Image analysis permits exploration of different, uncorrelated processes that would provide potential explanation for the same factor loadings. The formula for the square of the multiple correlation coefficient $R^2_{j(u)}$ to predict the *j*th unique factor is

$$R^2_{j(u)} = \frac{u_j^2}{s_j^2}, \tag{4}$$

where u_j^2 is the unique variance for the *j*th variable, and s_j^2 is the error estimate for predicting the *j*th variable from the n-1 other variables by multiple correlation (Mulaik, 1972). Mulaik explains that normally the unique variance u_j^2 is less than the error estimate s_j^2; but by image analysis, the FA model will not be determinate if $R^2_{j(u)}$ does not equal 1 for every *j*, which will only occur if $u_j^2 = s_j^2$. Mulaik emphasizes that the unique variance of each variable must equal the error estimate in predicting the variable from the other variables. From this discussion, the usefulness of image analysis in the characterization of a factor's relationship with a variable being studied should be evident.

The Alpha Reliability Analysis, alternatively termed *Cronbach's Alpha*, is a statistical tool used to determine the internal consistency of items in a survey and thereby relate the reliability of the instrument. Gliem & Gliem (2003) argue it is necessary to calculate and report Cronbach's Alpha coefficient for internal consistency reliability for scales or subscales. Cronbach's Alpha is defined as

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma^2_{Y_i}}{\sigma^2_X}\right), \tag{5}$$

where K is the number of components, σ_X^2 is the collected total score variance on the current sample, and $\sigma_{Y_i}^2$ is the component *i* variance on the sample. The Alpha reliability coefficient for each subscale – (a) context of learning satisfaction; (b) cognitive load satisfaction; and (c) overall satisfaction – is used to determine the reliability of the instrument.

The full set of analysis procedures used in this study also included the correlation of each item with each subscale (i.e., context of satisfaction, cognitive load, and overall satisfaction) total score. Further, the impact on reliability by removing each item from its corresponding scale and the covariance of the component subscales was used. The regression of cognitive load on satisfaction, and the regression of satisfaction on cognitive load were calculated. Finally, the study included an analysis of the satisfaction and cognitive load total subscale scores by the categories of the demographic student variables through the application of ad hoc hypothesis testing procedures (e.g., Scheffe).

Summary Analytic Procedures

The following is a summary of the analytics used on the final data.

1. The response distribution for each item.
2. The Alpha reliability coefficient for each subscale and for all scales when combined.
3. The impact on reliability of removing each item from its corresponding scale.
4. Correlation of the satisfaction and cognitive load total scores.
5. The covariance of the component subscales.
6. Factor analysis of the instrument using the Principal Component and Image procedures.

7. Analysis of the satisfaction and cognitive load total subscale scores by the categories of the demographic student variables through the application of ad hoc hypothesis testing procedures (e.g., Scheffe).
8. The regression of cognitive load on satisfaction.
9. The regression of satisfaction on cognitive load.

This study received IRB authorization (see SBE-08-05873). The IRB authorization is presented in *Appendix F: IRB Authorization Letters*.

Chapter Summary

Summary

The operational definitions begin this chapter. Then, the details to determine an approach to study cognitive load and student satisfaction with online learning are presented. An argument is made for studying within-subjects or between-subjects research on cognitive load, and a survey is presented as a viable strategy. Cognitive load items are derived from Mayer and Moreno's research (2003). The items for the context of online learning are derived from the Sloan Model (Dziuban et al., 2007; Moskal et al., 2009), and goal related items are derived from Deci (1975). Both context items and goal related items represent the satisfaction construct.

A pilot to test the instrument and procedures is described and some issues are revealed. This necessitated a restructuring of the instrument. The restructuring details are fully described and include using hypothetical situations.

A new data collection procedure is described to incorporate findings from the pilot. Multiple data analysis procedures for the final data are presented and discussed.

Bridge to Next Chapter

In the next chapter, the results of the data analysis are described.

CHAPTER FOUR: FINDINGS

In this chapter, findings from the data analysis from the survey are presented. Conceptually, this chapter is sequenced as analysis and post hoc analysis. The chapter includes seven sections, whereof the first three sections present analysis findings, and the final four sections present post hoc findings. The seven sections are as follows: (a) descriptive results; (b) reliability analysis; (c) correlation of satisfaction and cognitive load total scores; (d) factor pattern; (e) analysis of demographic categories; (f) regression analyses; and (g) selected responses to open-ended items. The final section, *selected responses to open-ended items*, includes four subsections: (a) reactions to feeling overloaded; (b) additional comments regarding satisfaction; (c) perceived strengths of online courses; and (d) perceived weaknesses of online courses. The chapter concludes with a summary and a bridge to the next chapter.

Descriptive Results

The total number of participants in the survey was 1,401, whereof 81 were incomplete in providing a response for every item, yielding a 94.2% full completion rate. The overall response rate for the survey remains speculative since the number of students solicited is only known to the 49 faculty members, who received the faculty solicitation message, and who may or may not have elected to participate in the study. In addition, some students received the solicitation message through other channels, such as the Associated Student Government, which elected to support this study and encouraged students to participate, or by way of students who forwarded the solicitation message to their peers. For this study, solicitation for participation was made only at the University of Central Florida. Participation was campus wide with known support coming from the College of Education, College of Business Administration, College of Engineering and

Computer Sciences, College of Arts and Humanities, College of Sciences, and the Burnett Honors College.

Total responses aggregated on the subscales were the following: cognitive load subscale was 1,321; the context of learning online subscale was 1,273; and the goals-rewards subscale was 1,307. Table 10, *Cognitive Load Item Distributions*, presents frequencies, percentages, means, and standard deviations for the cognitive load item distributions subscale. Scoring in the scale ranges from 5 (Strongly Agree) to 1 (Strongly Disagree).

Table 10

Cognitive Load Item Distributions

Response Categories	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree			
Item	N	%	N	%	N	%	N	%	N	%	M	SD
			Cognitive Load Items									
1.1) Use visual only formats	217	15.5	516	36.8	293	20.9	298	21.3	53	3.8	3.40	1.10
1.2) Replace some visual with audio	195	13.9	571	40.8	304	21.7	237	16.9	69	4.9	3.43	1.08
2.1) Use both visual and audio	428	30.6	639	45.6	211	15.1	74	5.3	15	1.1	4.02	0.88
2.2) Separate segments with time	231	16.5	591	42.2	408	29.1	114	8.1	23	1.6	3.65	0.91
2.3) Prepare with pre-training	356	25.4	594	42.4	303	21.6	97	6.9	16	1.1	3.86	0.92
3.1) Include extra material	133	9.5	307	21.9	325	23.2	445	31.8	158	11.3	2.86	1.18
3.2) Remove extra material	313	22.3	518	37.0	337	24.1	168	12.0	32	2.3	3.67	1.03
3.3) Instruct how to use extra material	395	28.2	636	45.4	259	18.5	57	4.1	17	1.2	3.98	0.87
4.1) Use of confusing material is ok	34	2.4	74	5.3	72	5.1	311	22.2	874	62.4	1.60	0.99
4.2) Organize visual materials to reduce scanning	520	37.1	599	42.8	183	13.1	54	3.9	15	1.1	4.13	0.87
4.3) Do not duplicate material in alternate modalities	336	24.0	430	30.7	331	23.6	226	16.1	44	3.1	3.58	1.12
5.1) Presentation requiring high memory is ok	51	3.6	175	12.5	378	27.0	550	39.3	210	15.0	2.49	1.02
5.2) Organize presentation to reduce high memory	496	35.4	676	48.3	160	11.4	35	2.5	3	0.2	4.19	0.75
5.3) Train to manage high memory presentations	188	13.4	513	36.6	397	28.3	202	14.4	66	4.7	3.41	1.05

By adding the contributions of *Strongly Agree* with *Agree*, and *Strongly Disagree* with *Disagree*, then examining instances with more than 75% of responses, we have the following results from the cognitive load scale:

1. Just over 76% (1,067) of respondents agree on item *Use both visual and audio* (2.1).
2. Approximately 80% (1,119) agree on item *Organize visual materials to reduce scanning* (4.2).
3. Nearly 84% (1,172) agree on item *Organize presentation to reduce high memory* (5.2).
4. Nearly 85% (1,185) disagree on item *Use of confusing material is ok* (4.1).

Item numbers (i.e., to the right of the item text) are retained in the list above as the initial digit indicates the Mayer and Moreno scenario type, which is associated with specific cognitive overload combinations. The initial item belongs to Mayer and Moreno Scenario Type 2, which addresses *essential* processing in both visual and audio channels. Two items belong to Scenario Type 4, which address the channels becoming overloaded from a confusing presentation of *essential* processing. The third item corresponds to *Representational Holding* or *Intrinsic Load*, where the fundamental complexity of material to be learned forces processing through working memory. Students are not satisfied with learning situations where a lot must be kept in memory. Overall, these findings generally indicate satisfaction when the cognitive load is managed through use of multiple learning channels (i.e., visual and auditory) and improving the design of learning materials by reducing scanning, high memory requirements, and confusing presentations.

In Table 11, *Satisfaction Item Distributions: Sloan Model and Goals-Rewards*, presents results from the satisfaction subscales. Scoring in the scale ranges from 5 (Strongly Agree) to 1 (Strongly Disagree).

Table 11

Satisfaction Item Distributions: Sloan Model and Goals-Rewards

Response Categories	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree			
Item	N	%	N	%	N	%	N	%	N	%	M	SD
					Satisfaction: Context of Online Learning							
7.1) Clear directions in syllabus and assignments	838	59.8	378	27.0	83	5.9	20	1.4	3	0.2	4.53	0.70
7.2) Easy to find answers	750	53.5	431	30.8	106	7.6	30	2.1	6	0.4	4.43	0.77
7.3) Be able to track progress	848	60.5	351	25.1	100	7.1	13	0.9	5	0.4	4.54	0.71
7.4) Require instructor's feedback, advice, or guidance	548	39.1	470	33.6	223	15.9	63	4.5	14	1.0	4.12	0.93
8.1) See relevance to major field of study	367	26.2	532	38.0	286	20.4	123	8.8	16	1.1	3.84	0.97
8.2) Be able to communicate with others in course	190	13.6	356	25.4	381	27.2	307	21.9	89	6.4	3.19	1.14
8.3) Need to be assessed often	282	20.1	601	42.9	307	21.9	107	7.6	23	1.6	3.77	0.93
8.4) Instructor only has online office hours	169	12.1	279	19.9	448	32.0	291	20.8	137	9.8	3.04	1.16
9.1) Need to be motivated to participate	432	30.8	498	35.6	238	17.0	130	9.3	24	1.7	3.90	1.03
9.2) Need routine activities to keep engaged	392	28.0	561	40.0	225	16.1	115	8.2	31	2.2	3.88	1.01
9.3) Believe active communications, discussions, or debates are necessary	207	14.8	421	30.1	354	25.3	263	18.8	76	5.4	3.32	1.13
9.4) Believe communications must be respectful	678	48.4	481	34.3	135	9.6	23	1.6	5	0.4	4.36	0.77
10.1) Want to go beyond required assignments	117	8.4	301	21.5	449	32.1	351	25.1	104	7.4	2.98	1.08
10.2) Need assignment options	275	19.6	616	44.0	319	22.8	103	7.4	9	0.6	3.79	0.88
10.3) Need opportunities to develop own solutions for assignments	196	14.0	563	40.2	449	32.1	101	7.2	13	0.9	3.63	0.86
10.4) Need due dates throughout course, not all due at end	660	47.1	373	26.6	177	12.6	81	5.8	34	2.4	4.17	1.04

Response Categories	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree			
Item	N	%	N	%	N	%	N	%	N	%	M	SD
					Satisfaction: Goals & Rewards							
12.1) Look for potential reward	284	20.3	644	46.0	272	19.4	97	6.9	17	1.2	3.82	0.9
12.2) Set goals based on future satisfaction	353	25.2	705	50.3	220	15.7	27	1.9	8	0.6	4.04	0.76
12.3) When challenged, satisfaction is its own reward	221	15.8	616	44.0	313	22.3	134	9.6	32	2.3	3.65	0.96
12.4) More satisfied when more challenged	83	5.9	284	20.3	446	31.8	343	24.5	158	11.3	2.84	1.09
13.1) Overall, more satisfied when I put in a lot of effort	178	12.7	543	38.8	393	28.1	158	11.3	48	3.4	3.49	0.99

Again, by adding the contributions of *Strongly Agree* with *Agree*, and *Strongly Disagree* with *Disagree* and examining instances where the contributions account for more than 75% of responses, we have the following results from the satisfaction scales:

1. Approximately 87% (1,216) of respondents agree on item *Clear directions in syllabus and assignments* (7.1).
2. Just over 84% (1,181) agree on item *Easy to find answers* (7.2).
3. Nearly 86% (1,199) agree on item *Be able to track progress* (7.3).
4. Nearly 83% (1,159) agree on item *Believe communications must be respectful* (9.4).
5. Just over 75% (1,058) agree on item *Set goals based on future satisfaction* (12.2).

Item numbers (i.e., to the right of the item text) are retained in the list above as they indicate whether the item belongs to Context (i.e., Sloan Model) or Goals-Rewards. Item five above is the only item that belongs to Goals-Rewards. Overall, items that strongly contribute to satisfaction reflect self-check or personal control aspects of online learning, with the single exception of respectful communications. Clear directions in the syllabus and assignments, finding answers easily, tracking progress, and setting goals based on future satisfaction represent areas where individuals assert control over their learning and adjusting strategies or priorities as necessary. Interestingly, these items would seem to be a composite of the final item, *set goals based on future satisfaction* since each listed item is goal-directed.

Student responses to the subscales should be contrasted with the degree of experience in online evironments. Two items in the instrument asked students to indicate how many online courses they have had, including the one they were enrolled at the time of the study. The classification of course type used for these two items reflect instances where students sometimes met with their instructors during class time (blended or type M courses) or rarely if ever met with their instructors (web-only or type W courses). While these two denominations of course types reflect specific offerings at the University of Central Florida, the definition of these course types was relaxed for this study. The “M” or “W” denominations only differentiate whether students physically met with their instructors during the course time or not.

Table 12, *Level of Experience with Online Learning*, presents student responses to their level of experience with online learning indicating how many blended and fully online courses they have had. Students reported that they had taken on average three blended and four fully online courses, indicating a fair amount of exposure with web courses. The range indicated a large amount of variability in students experience (range = 30, blended; 50, fully online).

Table 12

Level of Experience with Online Learning

	Item 21	Item 22
	Including courses you are taking this semester, how many blended (M) online courses have you taken?	Including courses you are taking this semester, how many fully online (W) courses have you taken?
N	1309	1307
Mean	2.9	3.8
Std. Error of Mean	0.1	0.1
Std. Deviation	3.4	4.4
Variance	11.9	19.7
Range	30	50

Reliability Analysis

Table 24, *Reliability Analysis of All Scales* (Appendix G), presents the Alpha reliability analysis on all three scales combined (α = .82). In the interest of determining the strengths or weaknesses of the individual scales, a reliability analysis with the alpha value of the item if deleted is presented below for each of the scales. The satisfaction scale is broken into two parts: the first is the context of online learning (Table 14), and the second is the goals-rewards of online learning (Table 15).

Table 13, *Reliability Analysis of Cognitive Load Scale*, presents the reliability coefficient for the cognitive load scale, based on standardized items (α = .49). The low value of the coefficient for this scale indicates the items within the scale can and should be improved. While α = .49 reflects a low to moderately acceptable reliability, this should not overly detract from the scale's intrinsic value, since this possibly represents the first reliability coefficient for a scale of mental effort.

Table 13

Reliability Analysis of Cognitive Load Scale (based on standardized items, α = .49)

Item	Cronbach's Alpha if item deleted
Use visual only formats (1.1)	.47
Replace some visual with audio (1.2)	.46
Use both visual and audio (2.1)	.45
Separate segments with time (2.2)	.45
Prepare with pre-training (2.3)	.45
Include extra material (3.1)	.49
Remove extra material (3.2)	.52
Instruct how to use extra material (3.3)	.44
Use of confusing material is ok (4.1)	.47
Organize visual materials to reduce scanning (4.2)	.47
Do not duplicate material in alternate modalities (4.3)	.46
Presentation requiring high memory is ok (5.1)	.45
Organize presentation to reduce high memory (5.2)	.49
Train to manage high memory presentations (5.3)	.43

Table 14, *Reliability Analysis of Satisfaction Context Scale*, presents the reliability coefficient for the satisfaction context scale, based on standardized items (α = .79). The coefficient reflects an acceptable indication of scale reliability.

Table 14

Reliability Analysis of Satisfaction Context Scale (based on standardized items, α = .79)

Item	Cronbach's Alpha if item deleted
Clear directions in syllabus and assignments (7.1)	.77
Easy to find answers (7.2)	.77
Be able to track progress (7.3)	.77
Require instructor's feedback, advice, or guidance (7.4)	.76
See relevance to major field of study (8.1)	.77
Be able to communicate with others in course (8.2)	.77
Need to be assessed often (8.3)	.77
Instructor only has online office hours (8.4)	.79
Need to be motivated to participate (9.1)	.77
Need routine activities to keep engaged (9.2)	.77
Believe active communications, discussions, or debates are necessary (9.3)	.77
Believe communications must be respectful (9.4)	.77
Want to go beyond required assignments (10.1)	.78
Need assignment options (10.2)	.77
Need opportunities to develop own solutions for assignments (10.3)	.77
Need due dates throughout course, not all due at end (10.4)	.78

Table 15, *Reliability Analysis of Satisfaction Goals and Rewards Scale*, presents the reliability coefficient for the satisfaction goals-rewards scale, based on standardized items (α = .71). As with the Satisfaction Context scale, the coefficient reflects a moderately acceptable indication of scale reliability.

Table 15

Reliability Analysis of Satisfaction Goals-Rewards Scale (based on standardized items, α = .71)

Item	Cronbach's Alpha if item deleted
Look for potential reward (12.1)	.68
Set goals based on future satisfaction (12.2)	.67
When challenged, satisfaction is its own reward (12.3)	.61
More satisfied when more challenged (12.4)	.66
Overall, more satisfied when I put in a lot of effort (13.1)	.64

Hypothesis Test: Correlation of Satisfaction and Cognitive Load Total Scores

A significant, moderate correlation ($r = .5$, $p < .01$) was found between Satisfaction (All) and Cognitive Load (All). The finding indicates there is a moderate relationship between satisfaction and mental effort. Further, $r^2 = .25$ indicates that the constructs share 25% common variance. One interpretation of the shared variance is that 25% of student satisfaction with online learning is explained by cognitive load. This finding permits the rejection of the null hypothesis.

Factor Analyses

A factor analysis produced three factors as shown in Table 16, *Factor Analysis - Principal Components - Pattern Matrix*. The eigenvalues of the item correlation matrix were plotted (i.e., Scree Plot) against each component with an obvious break at three factors, so those dimensions were retained for rotation (Cattell, 1966).

The Principal Component Analysis provides a means to reduce the items into a smaller number of latent variables. Setting a minimum value of .40 for salient pattern coefficients from the principal components analysis table, and identifying all items with equal or greater to that minimum value, produced the underlying components across three groups.

Table 16

Factor Analysis - Principal Components - Pattern Matrix(a)

Factors Item	Awareness	Challenge	Engagement
Be able to track progress (7.3)	.66		
Clear directions in syllabus and assignments (7.1)	.63		
Believe communications must be respectful (9.4)	.59		
Organize presentation to reduce high memory (5.2)	.55		
Easy to find answers (7.2)	.55		
Organize visual materials to reduce scanning (4.2)	.53		
Set goals based on future satisfaction (12.2)	.52		
Need due dates throughout course, not all due at end (10.4)	.43		
More satisfied when more challenged (12.4)		.73	
Overall, more satisfied when I put in a lot of effort (13.1)		.68	
When challenged, satisfaction is its own reward (12.3)		.61	
Include extra material (3.1)		.57	
Presentation requiring high memory is ok (5.1)		.55	
Want to go beyond required assignments (10.1)		.48	
Train to manage high memory presentations (5.3)		.43	
Be able to communicate with others in course (8.2)			.74
See relevance to major field of study (8.1)			.60
Need assignment options (10.2)			.59
Believe active communications, discussions, or debates are necessary (9.3)			.55
Require instructor's feedback, advice, or guidance (7.4)			.54
Need opportunities to develop own solutions for assignments (10.3)			.51
Need to be motivated to participate (9.1)			.48

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

The pattern matrix suggests that the first group reflect variables associated with ***becoming aware of criteria for success in an online course***. Being able to track progress, access to clear instructions, finding answers, and having multiple due dates for assignments seem to project students adjusting their strategies and priorities for learning from their performance in tact with course requirements. These ongoing adjustments originate from their awareness of course conditions and individual performance.

Two cognitive load items are incorporated into this construct: one having to do with the intrinsic complexity of the material, and the other with incidental load created by requiring visual scanning to understand material. Finally, one goal-reward item is a member of this construct: setting goals based on future satisfaction. These three items strengthen the construct's reflection of student awareness with course conditions. The cognitive load items reflect student interests to be able to work material efficiently without unnecessary mental effort. Setting goals based on future satisfaction serves awareness by tying level of necessary effort spent on current course conditions with expectations of suitable rewards.

The second pattern suggests ***the definition of challenge or the degree of effort to complete course requirements***. Two cognitive load items, *presentation requiring high memory* and being *trained to manage high memory presentations*, balance effort with preparation for that effort. Including extra material and being able to push beyond required levels of performance on assignments further reflect the importance of incorporating challenge into the construct. Finally, the three goals-rewards items tie satisfaction levels with levels of challenge.

The third pattern suggests ***elements to support engagement***. Varieties of communication forms, such as peer to peer, active discussions or debates, and with the instructor, reflect common ways students perceive engagement in a course. Course relevancy with major field of study, assignment options, and opportunities for own assignment solutions extend the concept of engagement through connections with larger goals and the option of taking ownership of the work produced. The final item, needing motivation to encourage participation, also fits the concept of engagement. Students will not engage if there is no motivation – optional assignments are often ignored.

In Table 17 following, *Factor Correlation Matrix - Principal Component Analysis*, the correlation between factors is presented.

Table 17
Factor Correlation Matrix - Principal Component Analysis

Factor	Awareness	Challenge	Engagement
Awareness	-		
Challenge	.00	-	
Engagement	.32	.31	-

Extraction Method: Image Factoring. Rotation Method: Promax with Kaiser Normalization.

While the correlation between *Awareness* and *Challenge* is zero, there is a positive correlation between *Awareness* and *Engagement* and between *Challenge* and *Engagement*. Interestingly, this would seem intuitive. Being aware of course conditions and performance should influence engagement, and a challenge that is properly set should positively influence engagement. Quite possibly the zero correlation between *Awareness* and *Challenge* reflects two aspects of the same construct.

The Image Analysis is an alternative analysis method to the Principal Components Analysis. The Pattern Matrix and Factor Correlation Matrix from the Image Analysis are presented in Tables 25 and 26 in Appendix H.

Analysis of Demographic Categories

Analysis of Variance (ANOVA) was calculated on all demographic items: age, marital status, academic standing, gender, number of children at home, and ethnicity. Table 18, *Significance from ANOVA Analysis*, presents the significance from the two independent variables, Cognitive Load (All) and Satisfaction (All) on each independent variable. Overall, two of the independent variables were significant: academic standing and gender. The Tukey Post Hoc test was used to further examine academic standing differences.

Table 18

Significance from ANOVA Analysis: Cognitive Load (All Types) and Satisfaction (All)

Independent Variable	Total CL All Types	Total Satisfaction (All)
Age	.183	.080
Marital Status	.476	.632
Academic Standing	.136	***.010***
Gender	**.019**	.231
Number of Children at Home	.153	.184
Hours Employed	.925	.077
Ethnicity	.546	.492

The Tukey Post Hoc test found the mean difference of 2.1 was significant at the .05 level between sophomore (n = 419) and senior (n = 316) groups for the dependent variable Satisfaction (All).

Regression Analyses

Regression analysis is used when a researcher is looking for a predictive relationship where the dependent variable is interval data and is normally distributed. The potentially useful result of the regression analysis is the generation of an equation that can be used to predict variable values.

Table 19, *Regression: Cognitive Load from All Satisfaction*, shows partial results of the regression analysis.

Table 19

Regression(b): Cognitive Load from All Satisfaction

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7443.67	1	7443.67	401.12	.000(a)
Residual	22435.59	1209	18.56		
Total	29879.26	1210			

a. Predictors: (Constant), Total All Satisfaction

b. Dependent Variable: Total CL All Types

There is a statistically significant relationship between the linear composite of the satisfaction scale (all) ($F_{1, 1209} = 401.12$, $p < .01$) and the cognitive load scale. Table 20, *Coefficients: Cognitive Load from All Satisfaction*, shows that nearly 25% of the variance in cognitive load can be accounted for by satisfaction, and the regression equation is:

$$\text{Cognitive Load} = 26.69 + .27(\text{Satisfaction-All}) \quad (6)$$

Table 20

Coefficients: Cognitive Load from All Satisfaction

Constant	All Satisfaction	R^2	SE
26.69	.27	.25	4.31

Table 21, *Regression: All Satisfaction from Cognitive Load*, presents the partial results of the regression analysis for predicting satisfaction from cognitive load.

Table 21

Regression(b): All Satisfaction from Cognitive Load

	Sum of Squares	df	Mean Square	F	Sig.
Regression	25376.21	1	25376.21	401.12	.000(a)
Residual	76485.10	1209	63.26		
Total	101861.31	1210			

a. Predictors: (Constant), Total CL All Types

b. Dependent Variable: Total All Satisfaction

There is a statistically significant relationship between the linear composite of the cognitive load scale ($F_{1, 1209} = 401.12$, $p < .01$) and the satisfaction scale (all). Table 22, *Coefficients: All Satisfaction from Cognitive Load,* shows that nearly 25% of the variance in cognitive load can be accounted for by satisfaction, and the regression equation is:

$$\text{All Satisfaction} = 34.88 + .92(\text{Cognitive Load}) \quad (7)$$

Table 22

Coefficients: All Satisfaction from Cognitive Load

Constant	Cognitive Load	R^2	SE
34.88	.92	.25	7.95

Selected Responses to Open-Ended Items

The survey instrument included several items that permitted students to openly respond to the prompt with text comments. In the following sections, samples have been extracted from among the available responses. The student narrative clearly mirrors the results of the quantitative analysis.

Reactions to Feeling Overloaded

Item six in the survey prompted students to respond to the following statement. “Please describe a situation in an online course when you feel you are *overloaded* (cognitively) and how you react to it.” To this prompt, 1,206 students responded (86.02%) and 196 students left no response (13.98%). Some student responses follow.

> “I feel that the required material for my online course is very much overwhelming. The required reading material is scattered, and confusing having nothing in common with the text book material. The amount of reading material is ridiculously large and the time frame to have the reading material complete are very short. The online readings that are

posted by the instructor & the TA are senseless to what the syllabus outlines. It seems as if the material was thrown together and does not comply with the syllabus."

"I took an interdisciplinary cornerstone course which had an overwhelming amount of work involved. None of the content of the course made sense, it was poorly organized, and the work appeared to be no more than busy work. I reacted by just grinding my way through it all; but hated every minute of the course and learned nothing because there was not time to actually study anything just keep churning out paper after paper."

"In one of my online classes, I had two text books, plus one very long (over 70 slides) powerpoint per chapter. There was too much information to take in and to remember the source it came from."

"I have an online class where the powerpoints are confusing and contain a lot of extra information. The powerpoints also conflict with the content of the assigned textbook."

These viewpoints would seem to follow the student response trends identified in the distributions and frequency analyses. Clearly written syllabi and assignment directions, overloading on visual materials that are either too much or deemed non-essential would seem to be pervasive perspectives.

Additional Comments Regarding Satisfaction

Item eleven in the survey prompted students to respond to the following statement. "Please comment on anything else that is important for you to be satisfied with in an online course." To this prompt, 893 students responded (63.69%) and 509 students left no response (36.31%). Some student responses follow.

“I need to know how I am doing so all grades need to be available as soon as they are graded.”

“It is often frustrating in online courses when teachers are not clear about what is expected of you. It is especially important that they are clear about expectations in an online setting versus a classroom, because online communication is so important. Like when working on modules, teachers will not be clear on what they want you to post each week. You will miss points even though you tried to please them.”

“I also think that when instructors simply give 10 reading assignments without any sort of guidelines other than "post about these", you are wasting resources by paying them to create the class and "teach" the class, and that I am wasting my time and money taking the class when I could simply have been given a lump of texts and asked to take an arbitrarily designed MC exam 18 weeks later for my semester grade. In general, have educators that are not told that they are teaching a class two weeks prior to the beginning of the semester, and maybe check up on some of the instructor's classes to see what it is they are doing and how exactly they are doing it. Most of my online classes have been immensely underwhelming and it's a shame that nearly everything that I've needed to do for my entire degree has been online. I feel sorely unprepared for my professional examination that I am taking a few months from now, despite the fact that I have currently received As in all of my foundational/major classes.”

“I wish there was a program that would teach you how to do any of the problems and assignments rather than just reading the textbook and attempting to teach yourself things that you have never been taught or seen before.”

Perceived Strengths of Online Courses

Item twenty-three in the survey prompted students to respond to the following statement. “What do you find to be the strengths of online courses?” To this prompt, 1,242 students responded (88.59%) and 160 students left no response (11.41%). Some student responses follow.

> “Self-paced, mobile (can connect anywhere), and improve written communication for 21st century skills.”
>
> “I enjoy being able to do things on my own schedule. It's convenient for me. I am more motivated to learn online and carry on discussions with my peers than trying to sit through a class.”
>
> “I like the independence of online courses. I feel that online courses help me with research, comprehension, and motivation.”
>
> “It helps me to be able to make a functional work schedule. Most employers don't like having to give you 2 hours off during the day to go take a class and I have been turned down (and actually fired from one job) for taking in-class classes during business hours.”

Perceived Weaknesses of Online Courses

Item twenty-four in the survey prompted students to respond to the following statement. “What do you find to be the weaknesses of online courses?” To this prompt, 1,271 students responded (90.66%) and 131 students left no response (9.34%). Some student responses follow.

> “None, except when instructors do not answer emails or require group work as the major weight of the grade.”

"There isn't the immediacy of responses from peers or professors. Professors should also be fluent in online class management. When a professor doesn't know how to run an online class, it shows, and oftentimes, grad students (especially) discredit that professor."

"Poor instructional design by the instructor, or a lacking of basic uniformity of presentation between online course format. Last minute assignments or last minute changes in assignments or nature of assessments without adequate lead time to anticipate those changes. Fully online lack the f2f interaction with both instructor and other students that I believe are important to engaged learning. Hybrids are my best experience."

"No relationship with professors, which can especially lead to difficulty getting recommendations for grad school and finding research opportunities. Hard to get quick clarification on a point."

"I do not think online courses have any weaknesses."

"Isolation from other students."

Chapter Summary

Summary

Multiple statistical procedures were followed to analyze 1,401 student responses to the survey on online learning. The distributions and frequency analyses showed preferences on presentation modalities (i.e., visual plus auditory), as well as including more emphasis on preparing students for material that is considered non-essential. Students strongly reacted that overload occurs when material is poorly organized or perceived as confusing, and they also reacted negatively to learning situations that demand keeping a lot in memory. Students seek clearly written syllabi, assignments, easy to locate answers, and timely responses from the instructor. Students also indicated they prefer routine activities to maintain engagement, respect shown in all communications, and that due dates are spread throughout a course rather than an "all due at end" strategy. More than half of the responding students indicate they goal-seek, meaning they look for potential rewards and set goals based on future satisfaction. Students also agree that they experience more satisfaction when they put in more effort. Student experience with online learning tended towards three courses in blended mode and four courses in web-only mode.

Cronbach's Reliability Analysis was run on all three scales separately, as well as on the composite scale. Reliability analyses showed acceptable limits for individual scales and their composite.

A significant correlation was found between cognitive load and satisfaction and three constructs were isolated using Principal Components Analyses. The three constructs suggest differences in student needs as they navigate through an online course.

The Analysis of Variance on the demographic categories did not yield any significant correlations. The Regression Analyses demonstrated the significant relationship between cognitive load and satisfaction. Nearly 25% of the variance in either scale can be accounted for by the other scale.

Finally, selections from student responses to four open-ended items were presented. The variety and quantity of responses were too large to be treated within the scope of this study. The extraction of these viewpoints must be done separately. However a light review of the responses would seem to affirm the findings found in the descriptive results.

Bridge to Next Chapter

In the next and final chapter, a discussion of the findings is presented together with the directions for further, follow-on research.

CHAPTER FIVE: CONCLUSIONS

In this chapter, findings are discussed. The chapter includes five sections: (a) interpretations; (b) strengths; (c) limitations; (d) future directions; and (e) final conclusion.

The first section, *interpretations*, includes three subsections: (a) relationship between cognitive load and satisfaction; (b) new student-centered constructs: awareness, challenge, and engagement; and (c) predicting cognitive load from satisfaction, or vice-versa.

The second section, *strengths*, includes three subsections: (a) studying cognitive load using scenarios; (b) instrument utility; and (c) Sloan model to derive context of online learning.

The third section, *limitations*, includes two subsections: (a) cognitive load scale reliability; and (b) breadth of study.

The fourth section, *future directions*, includes seven subsections: (a) relationship between satisfaction-cognitive load and learning; (b) qualitative analysis on data: theme extractions; (c) explore and improve cognitive load scale; (d) expand study across multiple institutions; (e) discipline specific studies; (f) field-based research and business; and (g) CAI and adjusting a course concurrently.

The final conclusion presents a final summary and a closing discussion.

Interpretations of Findings

In this chapter, the relationship that was discovered between cognitive load and satisfaction is discussed, as well as interpretations of the emergent constructs as they should be perceived by instructors and instructional designers, and the general utility of predicting cognitive load from satisfaction or satisfaction from cognitive load.

Relationship between Cognitive Load and Satisfaction

The scale used to index mental effort from cognitive load was developed from the results of twelve years of empirical research by Richard Mayer at the University of Santa Barbara in California. The data from that research permitted Mayer and Moreno (2003) to identify five cognitive overload scenarios where three kinds of cognitive load must be processed. Mayer and Moreno label the kinds of cognitive load as essential, incidental, and representational holding (Mayer & Moreno, 2003), and these kinds of cognitive load display a sort of fluidity that have dependence on an individual's expertise and skill when navigating learning tasks. This fluidity can be seen from the descriptions of the scenario types Mayer and Moreno identified where the kinds of cognitive load are seemingly mixed. This blend of cognitive load types further reflect the inherent difficulty in studying mental effort since the effects of cognitive load will vary in terms of kind, as well as between individuals for any given material that is to be learned. Studying cognitive load between subjects becomes impossible given the variations in processing that will be taking place for a group of individuals given the same learning task. However, these five scenarios provide an authentic context of cognitive overload that facilitates studies on mental effort.

By employing and associating the five scenarios to statements where students are to consider their satisfaction produced interesting results. The significant correlation between cognitive load and satisfaction with online learning was moderate, and the r^2 indicates the constructs share 25% common variance. The finding that prompted Capan, Lambert, and Kalyuga (2009) to speculate on motivation as a source explaining low mental effort being "…the result of low cognitive load or simply a lack of interest or engagement in activity" (p. 156) would seem to fit the discovered correlation. Cognitive load would decline with a corresponding decrease in expected satisfaction. Capan, Lambert, and Kalyuga correctly state the ambiguity of the witnessed effect, which would be difficult to explain without having a connection between satisfaction (as a complex construct of motivation) and cognitive load.

This study permits proposing the stance that the goals-rewards and contextual components of satisfaction are tied to the expected levels of cognitive load. The formulation from the regression analysis might be used to identify the level of satisfaction necessary to produce an estimated level of cognitive load. By example, if a particular learning task is known to require a high level of cognitive load, then a level of expected satisfaction could be calculated to provide a balanced motivator. Such a strategy would permit controls by the instructor to associate a large enough expected satisfaction to sustain necessary mental effort, whether that level of effort is low or high.

Conversely, the same formulation could be used to predict levels of cognitive load from satisfaction. If strongly satisfied students will commit more or persist longer to meet cognitive challenges, then the opposite would also be true. This perspective permits reconsidering the statement by Paas et al. (2005) that it is not merely the level of cognitive load that is influencing the investment of effort, it is how that effort is perceived as satisfying. Explaining the position of Paas et al. with the foregoing logic, we can consider cognitive load as a component within the complex construct of satisfaction. From this vantage, the degree of perceived difficulty, or expected level of cognitive load necessary, would play a secondary role to whether there will be derived satisfaction from the investment. This formulation is possible by recognizing the found relationship between cognitive load and satisfaction: the *degree* of either will first be subject to mutual influences.

The relationship found through this study implies a new perspective for consideration: within the context of learning online, cognitive load may function as its own construct, as well as represent some of the satisfaction construct. When in service as part of the satisfaction construct, cognitive load would function as one of multiple factors that contribute to satisfaction with an online course. Viewed this way, the relationship between cognitive load and satisfaction might clarify some other research results. Clark (1999) studied task efficacy as an influence on mental effort. Kanfer and Ackerman (1989) studied goal setting, efficacy, and the effects of self-regulatory activities in the acquisition of new skills that demanded various levels of cognitive load. For a moment, consider efficacy through the lens of the information processing model. Bandura (1982) describes efficacy as involving "…a generative capability in which component cognitive, social, and behavioral skills must be organized into integrated courses of action…" (p. 122). Bandura further clarifies the construct: "Perceived self-efficacy is concerned with judgments of how well one can execute courses of action required to deal with prospective situations" (p. 122). The dual processing theory suggests some processing during learning will be effortless, while some will be effortful. The automaticity, or effortless processing, becomes possible when neural structures do not require processing to pass through working memory. To permit "…orchestration and continuous improvisation of multiple subskills to manage ever-changing circumstances…" (Bandura, 1982, p. 122), the processing taking place is likely effortless, indicating processing is not taking place through the slow processing channel that includes working memory. Efficacy viewed this way might be considered as awareness that cognitive load is not expected to be considerable, or cognitive overload will be small or minimal. If in some instances cognitive load serves as a component within the construct of satisfaction, then the effects Kanfer and Ackerman (1989) found, "…individual differences in intellectual ability may exert an important influence on the efficiency with which persons who perceive themselves as capable of goal attainment engage in self-regulatory activities" (p. 686), could be explained through recognition that the cognitive load for such individuals may or may not be satisfying. For such individuals, the mental effort that Clark (1999) found to be an inverted-U, can also be explained similarly: at some point mental effort has diminished satisfaction value. Sustained cognitive load becomes less satisfying.

The ANOVA analyses on student demographic data revealed two statistically significant relationships between the seven tested independent variables and either satisfaction or cognitive load construct. The two variables found to be statistically significant were academic standing and gender. The post hoc analysis used was Tukey since the Scheffe revealed no significant results on any of the seven independent variables. The Tukey analysis revealed the significance was between sophomores and seniors. A closer inspection of the data revealed that freshmen were under-sampled. The finding suggests that the significance may be a result of unequal sampling and only becomes noticeable when there is sufficient difference in experience, such as the two years that separate sophomores and seniors. With gender, neither Tukey nor Scheffe post hoc analyses could be conducted since only two groups are involved. Again, the result could be due to under-sampling, but this is conjecture. Future research should include the gender demographic. However, the sampling procedure should be modified to improve participation equally to better determine if gender is influencing cognitive load.

New Student-Centered Constructs: Awareness, Challenge, and Engagement

Satisfaction is a complex construct. In this research, the construct is designed to explain student perceptions with online learning. The construct contains two major components: the context of learning and the goals-rewards associated with learning. The context of learning component was derived using the Sloan Model, where students contributed through a blind, iterative cycle to conceptualize elements within eight dimensions. The goals-rewards component was derived using Keller's ARCS model and Deci's (1975) cognitive approach of motivation. The two scales assembled (i.e., "satisfaction (all)") comprise twenty-one items. The two components thus assembled represent the richness of the situational context of online learning with Deci's perspective of satisfaction as an extrinsic and intrinsic motivator.

From the Principal Components Analysis, three factors were found, which were subsequently labeled *awareness*, *challenge*, and *engagement*. These factors represent a reduced organization of items from the satisfaction scale and the cognitive load scale. As described in the previous chapter, the factor labeled *Awareness* includes eight items. These items were suggested as describing how students in online learning programs rely on particular elements in an online course to stay informed of requirements and of their performance within the scope of the course. This grouping would seem to mirror findings by Shea et al. (2004) where both quantity and quality of interactions between instructor and students and between students were found to show a correlation between student satisfaction and reported learning. These interactions could be inferred as students receiving and sharing feedback to maintain performance within ALN environments. The information being sought and shared between Shea et al.'s students in the study supports the construct of *awareness* of performance requirements together with actual performance. From this analysis, the eight items that fall into the *awareness* group are the following (listed in order of greatest effect):

1. Be able to track progress
2. Clear directions in syllabus and assignments
3. Believe communications must be respectful

4. Organize presentation to reduce high memory
5. Easy to find answers
6. Organize visual materials to reduce scanning
7. Set goals based on future satisfaction
8. Need due dates throughout course, not all due at end

These items reflect the student's perspective, not the instructor's. These are areas within an online course on which students are most focused for staying on track. An instructor or instructional designer working this list would need to translate this list into guidelines when designing an online course. The guidelines might become the following:

1. Ensure that students are able to track their expected performance (i.e., what is due, when, etc.) and actual performance (i.e., assignments received, perhaps with some confirmatory message, grades or points, etc.) within reasonable frame of time. Students expect quite timely feedback, so the more responsive the instructor is with providing feedback, the more satisfied becomes the student.
2. Use a simple approach when developing syllabus explanations for required or expected performance, as well as in developing assignment instructions. Students are looking for clarity, or unambiguous directions, for how to succeed in the course.
3. Keep all communications respectful and demand all students do likewise. The nature of ALN coursework suggests there may be opportunities where students feel they may communicate differently than they would in a face-to-face situation. This item may have originated from a lack of enforcing online etiquette.
4. When presentations are designed for online delivery, consider student-level memory requirements for processing salient points. These points might be

exemplified with the following questions. What assumptions are being made regarding requisite knowledge to comprehend the presented material? Are students required to jump between information "pages" to assemble critical facts to learn the material?

5. What are the key questions students have regarding your course? Most of the key items students want to know always remain the same. "What must I turn in and when?" "Will the assignment be graded?" "How will this work be graded?" Etc. If a course includes some unique elements that differ from other courses, then an instructor should harvest such questions that will arise and integrate these into the location within the course where students will ask the questions.
6. When designing material for presentation in ALNs, ensure that students do not need to visually scan material to find the meaning of the presentation. Integrate legends or other explanatory elements into the design so that they are placed where they depict meaning.
7. Students will set their goals based on expectations of satisfaction. Therefore, instructors should design from this premise. If there is no satisfaction to be found in performing an activity, students will not likely engage. If the activity is complex and requires significant effort, use a rich assessment strategy, such as rubrics, with appropriate assignment of points or grades.
8. Students look for currency in the reports of their progress through a course. Therefore, students look for multiple check points to communicate their progress. This might be achieved by breaking large assignments into steps or components.

The factor labeled *challenge* includes seven items. From this analysis, the seven items that fall into the *challenge* group are the following (listed in order of greatest effect):

1. More satisfied when more challenged
2. Overall, more satisfied when I put in a lot of effort
3. When challenged, satisfaction is its own reward
4. Include extra material
5. Presentation requiring high memory is ok
6. Want to go beyond required assignments
7. Train to manage high memory presentations

As with the previous factor, an instructor or instructional designer working this list would need to translate this list into guidelines when designing an online course. The guidelines might become the following:

1. Students find greater satisfaction where there is some challenge. Challenges need to be relevant and appropriate. Students who find little relevancy with tasks in a particular course would be little interested in large challenges as their satisfaction expectations will be less than for students where the subject matter has greater relevancy. The design should incorporate a degree of certainty for overcoming the challenge if the performance details are clearly communicated.
2. Similar to the foregoing item, students perceive a connection between effort and satisfaction. The instructional design should incorporate an environment to permit a high level of effort being made within the course timeframe. Design a realistic schedule to support sustained, high levels of effort.

3. Students recognize the intrinsic value of challenges: to some degree, completion of a challenging assignment will in itself be satisfying. An instructor can leverage this recognition through careful design. Plan the challenges for student success, as long as required effort is made. Assess carefully and richly by using rubrics when possible. Communicate clearly and timely.
4. Students will expect extra material to learn or review in the fulfillment of challenging assignments. Item four and six in the *challenge* factor fit together. If a challenging assignment is given, ensure that the instructional design includes resources to support the student(s) who engage in the work beyond stated requirements.
5. Students will accept high memory requirements for presentations when they are trained to manage the processing requirements. Item five and seven in the *Challenge* factor fit together. If learning requires that students must keep a lot in mind to understand, then plan to train students how this might be achieved.

The final factor labeled *engage* also includes seven items. From this analysis, the seven items that fall into the *engage* group are the following (listed in order of greatest effect):

1. Be able to communicate with others in course
2. See relevance to major field of study
3. Need assignment options
4. Believe active communications, discussions, or debates are necessary
5. Require instructor's feedback, advice, or guidance
6. Need opportunities to develop own solutions for assignments

7. Need to be motivated to participate

As with the previous factor, an instructor or instructional designer working this list would need to translate this list into guidelines when designing an online course. The guidelines might become the following:

1. Students feel it's quite important to be able to communicate with fellow course mates within ALNs. Students dislike the feeling of isolation inherent with online learning environments. Incorporate communication into the course design and support opportunities where salient communications take place.
2. Students look for relevancy in all aspects of a course, as well as the larger view of academic programs. If a course isn't relevant to a field of study, students will have a different perspective regarding engagement in the entire course. If activities within a course are relevant to learn the material, students will have a positive perspective regarding engagement. Instructors and instructional designers should consider all activities for a degree of relevancy to the immediate topic, as well up hierarchically to larger levels, such as module and course. Assess activities using relevancy as a criterion to determine scoring.
3. Opportunities for assignment options are regarded as valuable to students. Students look for options, and it's possible that the availability of options support engagement. Instructors and instructional designers should provide options to assignments to present variety. Considered another way, the presentation of variety not only promotes interest, the options may appeal to student preferences and experiences.

4. As part of item one, students perceive that learning through active communications in a variety of forms is preferable to studying in isolation. Where possible, instructors and instructional designers should find and employ strategies that leverage active communications.
5. Students consider instructor feedback as a *required* element to their learning in ALNs. Instructor feedback can take many forms; however, students consider advice or guidance as valuable. In ALNs, instructors might consider multiple means by which students access instructors for feedback.
6. Fitting together with item three, students look for opportunities to take ownership of assignments. This item reflects students looking to be more involved with their learning. Allowing students some opportunity to direct the design of assignments returns some control over learning back to students and allow them to set their own standards (Astleitner & Wiesner, 2004). This approach follows a student-centered learning paradigm, where the instructor *facilitates* learning opportunities.
7. Students need motivation to participate. If the motivation is missing or absent, students will tend to not participate. Motivation to participate will originate from all of the items within the *engagement* factor.

To this point, discussion regarding the new factors revolved on what they represent as separate factors and how instructors or instructional designers might interpret meaning from them. What remains to be explored and discussed is the collective meaning of these factors. The correlations between the factors indicate variance sharing between *challenge* and *engagement* and between *awareness* and *engagement*, but not between *awareness* and *challenge*. One question that quickly comes to mind is whether these factors have a hierarchy. Perhaps *awareness* and *challenge* prepare and support *engagement* (i.e., does A + C = E or A*C=E?)

Such questions cannot be answered within this study, but they are raised because it is not enough to discuss the factors in isolation of each other since they emerged from the same data analysis. Placing these factors into a study that focuses on learning outcomes would be appropriate for a follow-on study. Clearly, and predictably, the initial question raises new questions.

Predicting Cognitive Load from Satisfaction, or Vice-Versa

Predicting levels of cognitive load could be very useful for instructors, instructional designers, and developers of educational products. The regression analyses revealed equations by which either cognitive load or satisfaction might be predicted from the other. The relationship between cognitive load and satisfaction requires more research confirmation. Confirmation can include benchmarking to investigate the accuracy of estimates of cognitive load or satisfaction.

The predictability of the level of cognitive load from satisfaction provides fresh insight into design efficiencies and the preparation students have with learning new material within ALNs. Through strategic use of the satisfaction scale, instructors could estimate the general level of cognitive load taking place. Instructors could use such knowledge to improve the sequence, pacing, strategies, media, and etc components of an instructional design. Improvements to instructional designs will not be possible without benchmarking. Instructors, instructional designers, and researchers can take multiple approaches to benchmarking: investigating course segments, a whole course, or even entire course programs using randomly selected time periods or set periods over several course terms. After benchmarking, instructors and instructional designers would employ the same method to inquire into how students are progressing. The results from those inquires set against the benchmarks will permit the instructor or designer to take steps to adjust the learning design.

Strengths

Studying Cognitive Load Using Scenarios

One of the strengths of this study is the use of Mayer and Moreno's (2003) cognitive load scenario types for studies involving cognitive load. Brunken, Plass, and Leutner (2003) are quite correct in their assessment of the difficulty to measure and study cognitive load:

> "…as research in individual differences has shown, cognitive load varies to a significant degree among learners. A particular instructional design can cause extraneous load in one learner, whereas the same design can induce germane load in another, which can even change the effect of the instructional design from enhancing to hindering knowledge construction. Within such an individualized view of cognitive load effects, within-subjects designs may not only be an alternative but may indeed offer more appropriate research designs" (Brunken, Plass, & Leutner, 2003, p. 59).

Cognitive Load Theory classifies three forms of cognitive processing: (using Sweller's terminology) germane, extraneous, and intrinsic. Brunken, Plass, and Leutner (2003) note the problematic nature of measuring cognitive load from the changing nature of the cognitive load type, the individual doing the processing, and the situation that presents the processing need. Cognitive processing becomes a shape-shifter that becomes an instructor's or instructional designer's trouble-maker. Brunken, Plass, and Leutner also identify that the shape-shifting aspect effectively limits research to within-subject designs since processing will cross categorical boundaries where studies use between-subject designs.

Lakeoff (1987) describes a concept that he terms *idealized cognitive models* (ICMs). ICMs do not exist in nature, but as constructs they facilitate understanding among individuals within a shared sphere of influence. ICMs are arbitrary and diminish in usefulness when crossing borders of shared influence. One example Lakoff presents is the difference in the notion of time between the Balinese and individuals within the western sphere of influence. The ICM in the context of this study is the learner processing categories. Situations where one learner perceives material as germane, versus a different learner perceiving the same as extraneous, create a sourcing problem when conducting between-subjects studies: there will be disagreement in categorizations.

Mayer and Moreno (2003) derived five scenarios from empirical research that spanned twelve years and 30 studies. The unique nature of the five scenarios is the grouping of particular cognitive load constructs that arise from common scenarios. The identity of the cognitive load types are embedded within the scenarios, while the scenarios themselves are sufficiently general to be recognizable in online learning environments. The scenarios themselves can be used as the pretext for studies since they will represent cognitive load processing types, as long as the researcher is not specifically looking to isolate any type. With this limitation in mind, the scenarios present opportunities for between-subject studies on cognitive load. Further, using the Mayer and Moreno scenarios, there remain possibilities for narrowing to particular cognitive load types by restricting the research to a specific scenario instead of using all five types as was the case with this study. The processing categories are useful; however, ultimately the arbitrary nature of any designation is useful only where and when we can affect student engagement with learning (Dziuban, Moskal, Bradford, Brophy-Ellison, & Groff, 2010). In many instances, the separation of processing into distinct types may not be necessary to support the goal of student engagement.

Instrument Utility

The instrument used to gather student data has broad utility. Derivatives of this instrument that emerge from the findings from the Principal Components Analysis will likely improve the instrument's utility. The two scales developed to capture cognitive load and satisfaction collectively consist of 13 items, which can be electronically delivered to students at any point during an online course. Further, the items can be formed to fit a specific course's needs; although this comes at the risk of reducing the scale's reliability.

The scales are designed to gather student perspectives in a holistic approach to elements that contribute (or not) to their satisfaction with an online course. This design approach permits studies on a wide variety of situations that comprise ALN infrastructures. While the "ALN" distinction conceptualizes the infrastructure as "asynchronous," the scale designs should function equally well for "synchronous" infrastructures.

The scales will also function equally well for studies in different academic disciplines. Since cognitive load is dictated by common neurological processes that are independent of a particular discipline, and since satisfaction refers to a range of feelings, from positive to negative, about a learner's accomplishments and learning experiences, the scales will be useful for studies in online learning across academic disciplines. The scales may have appeal for application outside of online learning, but they have no research basis for such use. The broad utility of the scales offers the potential for interesting follow-on research.

Sloan Model to Derive Context of Online Learning

While the foregoing described the general utility of all the scales, a specific discussion is warranted regarding the Sloan Model. As described elsewhere within this study, the Sloan Model is both a construct and a process to derive the components. The position taken within this research is that the Sloan Model functions to capture the context of learning that is associated with student satisfaction within ALNs. Context describes the situational criteria that influence satisfaction, and because of its nature, context continually changes. The goals-rewards construct is more durable (i.e., in terms of stability of application in different circumstances) since the construct mostly originates from biological and neurological functions. The Sloan Model offers an approach to leverage a proven construct or to follow a process to rebuild the scale for specific situational needs. This is a critical part of the model since context will present variety due to place or time, so adaptability is an important value.

The final value of the Sloan Model is the ability to transcend the ambiguity often associated with the notion of *satisfaction*. Satisfaction is complex and means different things to different people. The Sloan Model presents eight dimensions that capture at once the variety and the ingredients of student satisfaction with online learning. Inspection of the elements that compose the context of learning scale show the complexity of the construct since there are many parts that influence satisfaction. The Sloan Model can be likened to a Swiss Army knife of student satisfaction studies in online learning, able to be used in multiple conditions and situations. Without capturing the context of the online learning, research would fail to integrate the notion of self *and* context that remains the goal of current trends in motivation research (Järvelä, 2007).

Limitations

Cognitive Load Scale Reliability

One limitation to the study is results of the reliability analysis on the cognitive load scale: the cognitive load scale was not as strong as was the case with the satisfaction scale. There could be several reasons for this. The items reflect concepts that may be conceptually difficult to comprehend or present a common tendency for differences in interpretation. While a great deal of care was taken in the crafting of items, and the items were reviewed by experts, the scale retained some weaknesses that resulted with a reliability score of .49, which can and should be improved. A careful semantic review is a natural next step, where the review would include further examination of how each item correctly addresses the representative scenario described by Mayer and Moreno (2003). Then, items should be pilot-tested for conceptual and interpretative reliability.

With an overall goal of improving the reliability of the scale, future studies using a modified scale may result in improvements to the constructs derived through factor analysis and the predicative formulation from subsequent regression analysis. As previously stated elsewhere in this study, the reliability coefficient of .49 remains unique in that it may be a one its kind scale. From this perspective, this reliability coefficient is acceptable for a new scale and should be considered a success.

Breadth of Study

Another limitation with this study is the sample population. The sample population was not even. The resulting demographics showed that 59% of the respondents were female, against 35% male; freshman represented only 8% of the sample and graduates only 1.4%; and African-American ethnic group represented only 10% of the sample.

Several strategies may be taken to improve the sampling. While this initial study was restricted to a single institution, future studies should expand to include additional institutions in different geographies. A lot of effort went into soliciting support for this study from instructors actively teaching online in different colleges and departments across the institution. However, the results make apparent that some populations were not adequately solicited, in particular freshman, graduates, and African-Americans. The solicitation effort requires modification to ensure these populations are better sampled.

As a final note regarding sampling, future studies that include multiple disciplines similar to this study should add demographic variables regarding the college of the student's major field of study and an item to determine from where the student's online experience mostly originates. These items could be used to improve the picture whether perceived cognitive load is greater in particular areas of study.

Future Directions

Follow-on research in the area of cognitive load, student satisfaction, and learning is rich with opportunities. Some ideas are briefly explored.

Relationship between Satisfaction-Cognitive Load and Learning

Initial directions for follow-on research should focus on improving the reliability of the cognitive load scale that also includes other improvements described earlier in this chapter, namely improving the sampling and adding demographic items to capture college of major field of study and where the learning online experience originates. With a modification to the solicitation strategies, revised instrument scales, and expanded to include multiple institutions, follow-on studies should provide a more clear, perhaps confirmatory, understanding of the relationship between cognitive load and satisfaction for students learning online.

The next step will be to explore academic performance within the relationship framework of cognitive load and satisfaction. Early in this study, performance, or indications of learning, was separated from the scope. With an improved understanding of cognitive load and satisfaction, future studies that focus on academic results would provide valuable guidance to instructors and instructional designers, while also providing valuable direction for education researchers.

Qualitative Analysis on Data: Theme Extractions

The instrument used in this study included four open-ended items where students were asked to respond to how they manage cognitive overload situations, whether students had other satisfaction items that are important but were not asked, what are the perceived strengths of learning online, and what are the perceived weaknesses of learning online. The response rate was very good (i.e., between 64% and 91% responding, where N=1,401). The wealth of data in this sampling remains almost completely unexplored. A qualitative method to perform thematic extractions is appropriate for a follow-on study. This new qualitative study will be set within the context of findings from the current study and will contribute to the interpretation of the factors that emerged from the Principal Components Analysis.

Explore and Improve Cognitive Load Scale

Among the first follow-on studies to be explored includes improving the cognitive load scale. In addition, there is a unique opportunity to focus research on particular scenario types, where specific cognitive load types can become somewhat isolated. An example for such research would be focusing on scenario type five, where representational holding plays a role with essential processing. Learning more about the intrinsic complexity of learning materials will be useful in designing effective instructional strategies for difficult topics. Such a study should follow the approach taken with the current study and use a between-subjects method.

Discipline Specific Studies

One of the most necessary (and interesting) follow-on research will be to conduct a deep study with improved scales and solicitation methods in specific disciplines, where enrollment, retention, and academic success are more problematic, such as in the sciences, mathematics, engineering, and computer sciences. These deep studies would be tightly focused on specific levels of proficiency that require more collected data points and benchmarking. From this work, adjustments to instructional strategies can be devised and tested. The results will also provide validation to the research approach.

Field-based Research and Business

Other work that should follow this study is to employ formative or design-based research techniques that test the general method of sampling and analysis to identify necessary instructional adjustments for circumstances beyond higher education. The working world of business is not beyond the scope of benefitting from techniques and approaches identified through this study. Indeed, since training remains a steady need in business as procedures and technologies are constantly changing, and since an increasing portion of training leverages multimedia or online delivery infrastructures, business should represent a wealth of opportunity for future studies.

CAI and Adjusting a Course Concurrently

A final future direction for research will be to follow the work of Suzuki and Keller (2006) by using the layered model for online learning design and embedding elements of the satisfaction and cognitive load scales into self-paced, computer-assisted instructional designs, similar to work by Song and Keller (2001). The goal would be to create instructional design structures that self-adjust to learner reactions. This would be exciting and challenging work. Yet this direction is a natural extension from the current study and the identified follow-on studies.

Final Conclusion

This study set out to explore whether any relationship exists between cognitive load and student satisfaction with learning online. The study separated academic performance (a.k.a. "learning") from cognitive load and satisfaction to better focus on influences between cognition (from cognitive load) and motivation (from satisfaction). Considerations that remain critical to the field of instructional design, as they apply to learning online, were described and used to guide a review of the literature to find directions to fulfill the goal of this study. Key work by Mayer and Moreno (2003), Moskal et al. (2009), and Dziuban et al. (2007) led to the development of scales to be used in a survey of students with course work experience in online learning. The scale for cognitive load was drawn from Cognitive Load Theory and five cognitive overload scenarios identified through empirical research by Mayer and Moreno (2003). The scale for student satisfaction was drawn from Keller's ARCS Model, Deci's cognitive approach to motivation, and the Sloan Model from Moskal et al. (2009) and Dziuban et al. (2007).

A pilot study was conducted and faults with the instrument design were identified and corrected. The study was conducted and 1,401 students responded to an instrument that contained 24 items during a data collection phase that lasted approximately four weeks. Multiple analysis techniques were used, and among the findings was a positive, moderate, and significant ($p < .01$) correlation between cognitive load and satisfaction. Approximately 25% of the variance is shared between cognitive load and satisfaction. Reliability analysis was conducted on all the scales and revealed that the cognitive load scale reliability was .49; for the satisfaction scale, reliability was .79; and for the full combined scale, reliability was .82. Further, new constructs emerged from a Principal Components Analysis that suggests a refined view of student perspectives and potential improvement for instructional design guidelines. A regression analysis produced an equation that can be used to predict cognitive load from satisfaction or satisfaction from cognitive load.

The final discussion of results demonstrated the utility of the findings. From the review of the literature, a correlation has never been found between cognitive load and satisfaction. The significance of this finding presents new opportunities to study and improve online instruction. Guidelines for developing online course designs using interpretations of the emerged factors are made. The usefulness of predicting cognitive load from satisfaction is discussed as a tool to support instructional adjustments. Strengths and weaknesses of the study are discussed. The key points from this discussion include that the cognitive load scale permits between-subject studies, and the broad utility of the instrument (i.e., the instrument can be used in many disciplines, at multiple opportunities during a course, and across multiple institutions, as well as permit a variety of interesting follow-on studies). Further, the Sloan Model is identified as particularly useful as both a scale and a process to derive and explore the context of learning online. The cognitive load scale is identified as requiring follow-on work to improve its reliability. The breadth of the study is also an area to improve for future studies, as areas in the sampling are not strong.

Future directions for research include the following: expanding the study to explore how the cognitive load-satisfaction relationship influences learning; a qualitative analysis on data to extract themes; explore and improve cognitive load scale to focus on particular load types, such as representational holding and essential processing; studying specific disciplines or technologies; conducting field-based research that follow formative or design-based research techniques and include business as a source for mutually beneficial research; and investigations into embedded and layered approaches to integrating knowledge of the relationships into computer-assisted instructional designs. At a minimum, all follow-on work will contribute to potentially confirming the findings of this study, as well as improving guidance to instructors and instructional designers who directly affect students studying through online learning course environments and the satisfaction of those students' experiences.

Satisfaction is important and useful. Determining student satisfaction with online learning is not only important institutionally, but the knowledge is also useful for instructors, instructional designers, and administrators. Beyond merely providing reaction information as some have historically contended, student satisfaction data provides insights into instructional design efficiencies and levels of cognitive load. The predictability of expected cognitive load across a variety of cognitive processing types will aid in the discovery of inefficiencies or other problematic situations that arise, but currently they may be unrecognizable for their true nature. The inefficiencies and problematic situations may lead to small enrollment, low retention rates, or poor student performance. Instructors or instructional designers may be unable to recognize the source leading to these possible outcomes.

The starting point of this study was the reflection that cognition and motivation may be in some way connected, and that research that focuses on learning outcomes should wait until the cognition-motivation relationship is better understood. From this study of online learning, it has been shown that cognitive load and satisfaction have a relationship. The toolbox for instructors and instructional designers increased in size and utility. Studying student satisfaction data now tells the instructor, instructional designer, administrator, or researcher more about the student experience. Such knowledge can be acted upon with increased confidence. With judicious use of the tools and analytics described in this study, instructional designs can be reviewed for mismatches where cognitive load is exceptional or unnecessary, or perhaps necessary but inappropriately prioritized from a student's perspective. Student satisfaction reveals more than expected. We should now expect to learn more about this relationship, and the reach of this relationship into learning outcomes. From such a future perspective, satisfaction may very well continue to reveal more than expected. And from that, student satisfaction remains important and useful.

APPENDIX A: THOROUGHNESS AND CITATION QUALITY

Overview

In table 23 below, *Results of Hjørland Thoroughness Analysis and Citation Quality Analysis to Guide the Review of Literature*, Hjørland's Thoroughness Analysis is combined with a partial Citation Quality Analysis as an argument for the overall quality of the review of the literature. In a case study on information retrieval in psychology, Hjørland (1988) focuses on the search strategy, selection of sources, and the construction of the search profile for a Swedish dissertation. Hjørland's perspective originates with findings from the American Psychological Association that indicated "…informal and unsystematic search behavior plays a dominant role…" (p. 40) in literature searches. Given that this work plays a decisive role in research, Hjørland argues that research efficiencies can be improved and that problems in research searches should be prioritized. Hjørland identified eight facets, or points of view, that should be used when searching for salient work to be included in literature reviews for the social sciences. These eight facets balance perspectives while facilitating the process of determining which works are relevant. Hjørland notes that literature searches and reviews evolve or change through the investigation and writing process. Problems with selection material "…tend to expand, so that in the end what one finds relevant is something completely different from what one deemed relevant at the start" (Hjørland, 1988, p. 52). Using the facets to guide search efforts provides focus, while also providing differing perspectives that strengthen the overall analysis that emerges from the review.

The eight facets are the following:

1. the research method applied
2. the theoretical frame of reference

3. common facets, such as time, form, and place
4. the psychological processes involved
5. psychobiological aspects
6. individual characteristics, such as sex, age, and personality traits
7. social and cultural conditions
8. the aim of application

Beile, Boote, and Killingsworth (2004) present a strong argument that reviewing the quality of citations used in dissertation research serves diverse audience needs. First, citations provide an indication of an author's "…ability to engage in an extensive scholarly endeavor, and that successful doctoral students should be comprehensive and up to date in reviewing the literature" (p. 347). Not only does this serve the author, but it serves the author's dissertation committee and the college within which research efforts fall by providing a perspective of the skill and knowledge of a topic domain the author currently demonstrates. Review and analysis of the citations provides an opportunity to redress skills or knowledge that might be lacking, while also allowing a convenient mechanism for between-subjects reviews on the performance of groups of doctoral students. Second, citations, through the bibliography, provide librarians with an "…expedient approach to effective collection development" (p. 347). This second point assumes that citations are of high quality, which is not only of importance to librarians, but to dissertation committees and colleges as well.

Beile, Boote, and Killingsworth (2004) calculate citation quality by reviewing each citation on three criteria – (a) scholarliness, (b) currency, and (c) appropriateness of fit to the development of the topic – where scholarliness is rated on a four-point scale, and currency and appropriateness is rated on a three-point scale. Regarding scholarliness, the focus for the highest score is derived by considering whether the source originates from empirical, peer-reviewed journal articles rather than general magazines. Regarding currency, the focus for the highest score is derived by considering whether the source is retrospective or contemporary. Finally, regarding appropriateness, the focus yielding the highest score is derived by how well the source contributes to the author's argument. Beile et al. (2004) provide an example of this by questioning an author's need to develop a rationale for use of a particular learning theory is best served by referring to a book or to an entry in an encyclopedia.

In this analysis, ratings on a point scale are not used for any of the criteria, and the third criterion, appropriateness, is also not used at all. Instead, scholarliness and currency are the primary focus as they serve well the need to determine quality. The criterion *appropriateness* was excluded simply for concern with self-rating bias.

Discussion

The results of the material used in the review of the literature as the research process progressed are presented in table 23 below within the context of the eight facets as they serve the purpose of the review. Each article is presented in an abbreviated form. The leading three authors' last names are included, with the year of publication and the title, along with an indicator of the publication type. Publication types include the following:

- A: Article
- B: Book
- b: Bulletin
- P: Paper presented at association conference
- R: Report
- W: Website

- PR: Peer-Reviewed
- U: Unpublished manuscript

To gauge the quality of citations used within the review, the age since publication is provided, as well as counts within the following categories:

- 5 years or less old (<5)
- Greater than 5 years to less than or equal to 10 years (<10)
- Greater than 10 years to less than or equal to 15 years (<10)
- Greater than 15 years to less than or equal to 20 years (<20)
- Greater than 20 years (20+)

The following summarizes the results of this combined quality analysis. 20% of the materials were published less than five years from the time of this review's writing, and 26% were published more than five years, but less than or equal to ten years ago. Fully 68% of the articles used within this review are less than 20 years old and 49 (41%) of the 120 articles are from peer-reviewed journals. Of the materials used in this review, (53%) originate from journal articles and (38%) originate from books, which together represent 91% of all cited materials.

Most of the cited works fall within Hjørland's facet *Psychological Processes*, as should be expected since this study is an exploration of this domain. In an effort to promote a detailed review with cross-referencing, the general categories that follow Hjørland's facets include further sub-categorization using the subheadings used in the review of the literature (i.e., chapter 2). This organizational structure facilitates future research by identifying past relevant works, topic area weaknesses or strengths, and tracking trends in research studies with narrow subject domains. Of particular interest for the field of instructional design, Hjørland's facet *Sphere of Application* might hold special utility. Building a reference table (and expanding the one presented here) with topic areas that merge with one another should support the tracking of research trends and saliency of major works. It remains a formidable challenge to follow the multi-directional efforts that occur in one topic area that have impact on an associated area. In this literature review, evaluation techniques used in instructional design are reviewed by their own merits, while coupling them with the specific sphere of practice in multimedia and online learning, and aligning their designs with learning and motivation principles. Also of interest, especially given the complexity of this research topic, is the analysis of material used for the theoretical orientation. Hjørland's facet provides a convenient window into key works that are further sub-categorized by topic area, which can be used in subsequent research where more detailed connections with relevant works can be explored or added.

Table 23

Results of Hjørland Thoroughness Analysis and Citation Quality Analysis to Guide the Review of Literature

Research methods:	Literature Review Research Methods			Age	<5	<10	<15	<20	20+
	* Boote, Beile (2005). Scholars before researchers: On the centrality of the dissertation literature review in research preparation	A	PR	5	X				
	* Hart (1998). Doing a literature review: Releasing the social science research imagination	B		12			X		
	* Hjørland (1988). Information retrieval in psychology: Implications of a case study	A	PR	22					X
	Survey and Meta-Analyses								
	* Muilenburg, Berge (2005). Student barriers to online learning: A factor analytic study	A	PR	5	X				
	* Sun, Tsai, Finger (2008). What drives a successful e-learning? an empirical investigation of the critical factors influencing learner satisfaction	A	PR	2	X				
	* Dziuban, Hartman, Moskal (2007). Student involvement in online learning	R		3	X				

Theoretical Orientation:	Motivation Theory			Age	<5	<10	<15	<20	20+
	* Deci (1975). Intrinsic motivation	B		35					X
	Keller - ARCS Model of Motivation Design								
	* Keller (1983). Motivational design of instruction	B		27					X
	Context of Motivation								
	* Järvelä (2001). Shifting research on motivation and cognition	B		9		X			
	Information Processing Theory								
	* Miller (1956). The magical number seven, plus or minus two: Some limits on our capacity for information processing	A	PR	54					X
	* Baddeley (1986). Working memory: Theory and practice	B		24					X
	* Baddeley (2001). Is working memory still working?	A	PR	9		X			
	Cognitive Load Theory								
	* Sweller,Van Merrienboer, Paas (1998). Cognitive architecture and instructional design	A	PR	12			X		
	* Mayer, Moreno (2003). Nine ways to reduce cognitive load in multimedia learning	A	PR	7		X			
Time, Place, Form:	English (French and Swedish considered) 1938 - 2009								
Psycho-logical Processes:	Motivation Theory								
	* Song, Keller (2001). Effectiveness of motivationally adaptive computer-assisted	A	PR	9		X			
	* Volet (2001). Emerging Trends in Recent Research on Motivation in Learning Contexts	B		9		X			
	* Sorrentino, Higgins. (1986). Motivation and cognition: Warming up to synergism	B		24					X
	* Nisbett, Ross (1980). Human inference: Strategies and shortcomings of social judgment	B		30					X
	* Schunk, Ames, & Ames (1989). Research on motivation in education. vol. 3: Goals and cognitions	B		21					X

Time, Place, Form:	English (French and Swedish considered) 1938 - 2009				Age	<5	<10	<15	<20	20+
	*	Bandura (1986). Social foundations of thought and action: A social cognitive theory	B		24					X
	*	De Corte (2000). Marrying theory building and the improvement of school practice: A permanent challenge for instructional psychology	A	PR	10		X			
	*	Volet (2001). Understanding learning and motivation in context: A multi-dimensional and multi-level cognitive–situative perspective	B		9		X			
	*	Blumenfeld (1992). Classroom learning and motivation: Clarifying and expanding goal theory	A	PR	18				X	
	*	Hickey (1997). Motivation and contemporary socio-constructivist instructional perspectives	A	PR	13			X		
	*	Turner, Meyer (2000). Studying and understanding the instructional contexts of classrooms: Using our past to forge our future	A	PR	10		X			
	*	Cole, Engeström (1993). A cultural-historical approach to distributed cognition	B		17				X	
	*	DeCharms (1968). Personal causation	B		42					X
	*	Travers (1977). Essentials of learning (4th ed.)	B		33					X
	*	Keller (1999). Using the ARCS motivational process in computer-based instruction and distance education	A	PR	11			X		
	*	Huang, Huang, Diefes-Dux (2006). A preliminary validation of attention, relevance, confidence and satisfaction model-based instructional material motivational survey in a computer-based tutorial setting	A	PR	4	X				
	*	Hirumi (2005). ARCS model of motivational design: Workshop materials	U		5	X				
	*	Maw,Maw (1968). Self-appraisal of curiosity	A	PR	42					X
	*	Berlyne (1964). Emotional aspects of learning	A	PR	46					X

Time, Place, Form:	English (French and Swedish considered) 1938 - 2009			Age	<5	<10	<15	<20	20+
	* Kaplan (1964). The conduct of inquiry	B		46					X
	* Hull (1943). Principles of behavior: An introduction to behavior theory	B		67					X
	* Maslow (1954). Motivation and personality	B		56					X
	* Rosenzweig, Murray (1938). Explorations in personality	B		72					X
	* McClelland, Atkinson, Clark (1953). The achievement motive	A	PR	57					X
	* Bandura (1977). Self-efficacy: Toward a unifying theory of behavioral change	A	PR	33					X
	* Seligman (1975). Helplessness	B		35					X
	* Rotter (1954). Social learning theory and clinical psychology	B		56					X
	* Weiner (1974). Achievement motivation and attribution theory	B		36					X
	* Weiner (1979). A theory of motivation for some classroom experiences	A	PR	31					X
	Research Approaches to Studying Student Satisfaction								
	* Shea, Fredericksen, Pickett (2004). Faculty development, student satisfaction, and reported learning in the SUNY learning network	B		6		X			
	* Chickering, Gamson (1987). Seven principles for good practice in undergraduate education	bu		23					X
	* Chickering, Ehrmann (1996). Implementing the seven principles: Technology as lever	bu		14			X		
	* Ehrmann, Zuniga (1997). The flashlight evaluation handbook	B		13			X		
	* Thurmond, Wambach, Connors (2002). Evaluation of student satisfaction: Determining the impact of a web-based environment by controlling for student characteristics	A	PR	8		X			

Time, Place, Form:	English (French and Swedish considered) 1938 - 2009			Age	<5	<10	<15	<20	20+
	* Astin (1993). Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education	B		17				X	
	* Grant, Thornton (2007). Best practices in undergraduate adult-centered online learning: Mechanisms for course design and delivery	A	PR	3	X				
	* Glaser, Strauss (1967). The discovery of grounded theory: Strategies for qualitative research	B		43					X
	* Summers, Waigandt, Whittaker (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class	A	PR	5	X				
	* Song, Singleton, Hill (2004). Improving online learning: Student perceptions of useful and challenging characteristics	A	PR	6		X			
	* Young, Norgard (2006). Assessing the quality of online courses from the students' perspective	A	PR	4	X				
	The Mental Work of Learning: An Overview								
	* Bruning, Schraw, Norby (2004). Cognitive psychology and instruction. (Fourth Edition ed.)	B		6		X			
	* Woolfolk (1993). Educational psychology (5th ed.)	B		17				X	
	Dual Processing Theory: A Brief Discussion of Expertise								
	* Feldon (2007). Cognitive load and classroom teaching: The double-edged sword of automaticity	A	PR	3	X				
	* Sweller (1988). Cognitive load during problem solving: Effects on learning	A	PR	22					X
	Orientation to Cognitive Load Theory								
	* Paas, Renkl, Sweller (2003). Cognitive load theory and instructional design: Recent developments	A	PR	7		X			
	* Paivio (1983). The empirical case for dual coding	B		27					X

Time, Place, Form:	English (French and Swedish considered) 1938 - 2009				Age	<5	<10	<15	<20	20+
	*	Paivio (1990). Mental representations: A dual coding approach	B		20				X	
	*	Wittrock (1989). Generative processes of comprehension	A	PR	21					X
	*	Mayer (1999). The promise of educational psychology: Vol. 1, learning in the content areas	B		11			X		
	*	Mayer (2002). The promise of educational psychology: Vol. 2, teaching for meaningful learning	B		8		X			
	*	Clark, Mayer (2007). E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning (2nd ed.)	B		3	X				
	*	Reigeluth (1979). In search of a better way to organize instruction: The elaboration theory	A	PR	31					X
	*	Reigeluth, Darwazeh (1982). The elaboration theory's procedure for designing instruction	A	PR	28					X
	*	Reigeluth (1999). The elaboration theory: Guidance for scope and sequence decisions	B		11			X		
	Other Connections between Cognitive Load Theory and Instructional Design: A Brief Review									
	*	Capan,Lambert, Kalyuga (2009). Student perceptions and cognitive load: What can they tell us about e-learning web 2.0 course design?	A	PR	1	X				
	Measuring Cognitive Load									
	*	Paas,Van Merriendboer (1994). Measurement of cognitive load in instructional research	A	PR	16				X	
	*	Brunken, Plass, Leutner (2003). Direct measurement of cognitive load in multimedia learning	A	PR	7		X			
	*	Kalyuga, Chandler, Sweller (1999). Managing split-attention and redundancy in multimedia instruction	A	PR	11			X		

Time, Place, Form:	English (French and Swedish considered) 1938 - 2009			Age	<5	<10	<15	<20	20+
	* Rubio, Díaz, Martín (2004). Evaluation of subjective mental workload: A comparison of SWAT, NASA-TLX, and workload profile methods	A	PR	6		X			
	* Paas, Tuovinen, Tabbers (2003). Cognitive load measurement as a means to advance cognitive load theory	A	PR	7		X			
	* Salomon (1983). The differential investment of mental effort in learning from different sources	A	PR	27					X
	* Salomon (1984). Television is 'easy' and print is 'tough': The differential investment of mental effort in learning as a function of perceptions and attributions	A	PR	26					X
	* Paas, Tuovinen, Van Merrienboer (2005). A motivational perspective on the relation between mental effort and performance: Optimizing learner involvement in instruction	A	PR	5	X				
Psycho-biology:	The Mental Work of Learning: An Overview								
	* Miller (1994). The magical number seven, plus or minus two: Some limits on our capacity for processing information	A	PR	16				X	
	* Peterson, Peterson (1959). Short-term retention of individual verbal items	A	PR	51					X
	* Waugh, Norman (1965). Primary memory	A	PR	45					X
	* Greene (1992). Human memory: Paradigms and paradoxes	B		18				X	
	* Ericsson, Chase,Faloon (1980). Acquisition of a memory skill	B		30					X
	* Ashcraft (1994). Human memory and cognition (2nd ed.)	B		16				X	
	* Cowan (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity	A	PR	9		X			
	Support for Motivation Theory								
	* Dubuc (February, 2009). The brain from top to bottom	W		1	X				

Individuals and Personality:	These areas of focus are integrated into psychological processes.		Age	<5	<10	<15	<20	20+
Social and Cultural Conditions:	These areas of focus are integrated into psychological processes.							
Sphere of Application:	Evaluation in Instructional Design							
	* Gustafson, Branch (2002). What is instructional design?	A	8		X			
	* Spector, Davidsen (2000). Designing technology enhanced learning environments	B	10		X			
	* Ramsden (1992). Learning to teach in higher education	B	18				X	
	* Biggs (1999). Teaching for quality learning at university	B	11			X		
	* McLoughlin, Luca (2001). Quality in online delivery: What does it mean for assessment in E-learning environments?	P	9		X			
	* Schankman (2004). Holistic Evaluation of an Academic Online Program	P	6		X			
	* Dick (2002). Evaluation in instructional design: The impact of Kirkpatrick's four-level model	A	8		X			
	* Kirkpatrick (1996). Great ideas revisited: Revisiting kirkpatrick's four level model	A	14			X		
	* Newstrom (1978). Catch-22: The problems of incomplete evaluation of training	A	32					X
	* Hamblin (1974). Evaluation and control of training	A	36					X
	* Clement (1982). Testing the hierarchy theory of training evaluation: An expanded role for trainee reactions	A	28					X
	* Holton (1996). The flawed four-level evaluation model	A	14			X		
	* Brinkerhoff (1988). An integrated evaluation model for HRD	A	22					X

Sphere of Application:		Evaluation in Instructional Design			Age	<5	<10	<15	<20
	*	Irlbeck, Kays, Jones (2006). Phoenix Rising: Emergent models of Instructional Design	A	PR	4	X			
	*	Sims, Jones (2003). Where practice informs theory: Reshaping instructional design for academic communities of practice in online teaching and learning	A		7		X		
	*	Bates (2004). A critical analysis of evaluation practice: The kirkpatrick model and the principle of beneficence	A		6		X		
	*	Prensky (2002). The motivation of gameplay	A		8		X		
		Multimedia Learning							
	*	Mayer (2005). Cognitive theory of multimedia learning	B		5	X			
	*	Allen,Seaman (2007). Online nation: Five years of growth in online learning	R		3	X			
	*	Allen, Seaman (2008). Staying the course: Online education in the united states, 2008	R		2	X			
	*	Garrison, Akyol (2009). Role of instructional technology in the transformation of higher education	A	PR	1	X			
	*	Shea, McCall, Ozdogru (2006). Adoption of the multimedia educational resource for learning and online teaching (MERLOT) among higher education faculty: Evidence from the state university of new york learning network	W		4	X			
	*	Cook, Zheng, Blaz (2009). Measurement of cognitive load during multimedia learning activities	B		1	X			
	*	Andres (2004). Multimedia, information compexity, and cognitive processing	A		6		X		
	*	Clark (2001). Learning from media: Arguments, analysis, and evidence	B		9		X		
	*	Kozma (1994). Will media influence learning? Reframing the debate	A	PR	16				X

Sphere of Application:	Evaluation in Instructional Design					Age	<5	<10	<15	<20	
	*	Clark, Yates, Early, Moulton (In press). An analysis of the failure of electronic media and discovery-based learning: Evidence for the performance benefits of guided training methods		B		0	X				
	*	Clark,Feldon (2005). Five common but questionable principles of multimedia learning		B		5	X				
	*	Bernard, Abrami, Lou (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature		A	PR	6		X			
	*	Sitzmann, Kraiger, Stewart (2006). The comparative effectiveness of web-based and classroom instruction: A meta-analysis		A		4	X				
	Aligning Design with Learning and Motivation Principles										
	*	Rowntree (1992). Exploring open and distance learning		B		18				X	
	*	Visser, Plomp, Kuiper (1999). Development research applied to improve motivation in distance education		P		11			X		
	*	Keller, Suzuki (2004). Learner motivation and e-learning design: A multinationally validated process		A		6		X			
	*	Moore (1993). Theory of transactional distance		B		17				X	
	*	Northrup (2001). A framework for designing interactivity into web-based instruction		A	PR	9		X			
		Totals	%	120		Age	<5	<10	<15	<20	20+
		A: Article	53%	63			24	31	13	13	39
		B: Book	38%	46							
		bu: Bulletin	2%	2							
		P: Paper presented at association conference	3%	3							
		R: Report	3%	3							
		W: Website	2%	2							
		PR: Peer-Reviewed	41%		49						
		U: Unpublished manuscript	1%	1							

Currency of citations:		% of Total	Cum.	Cum. % of Total
5 years or less old (<5)	24	20%	24	20%
Greater than 5 years to less than or equal to 10 years (<10)	31	26%	55	46%
Greater than 10 years to less than or equal to 15 years (<10)	13	11%	68	57%
Greater than 15 years to less than or equal to 20 years (<20)	13	11%	81	68%
Greater than 20 years (20+)	39	33%	120	

APPENDIX B: TOOLS TO DERIVE CONTEXT

The following presents the form used to derive student perspectives on the context of online learning following the structure of the Sloan Model.

Instructions: Individual assignment

Thank you for participating in this study. Your efforts and contributions will help online faculty and support personnel to understand what students look for in online instruction or opportunities for learning through online courses at UCF.

This assignment has two parts. Please read the entire assignment carefully before beginning. Do not write your name or indicate your identity anywhere within this form. This is to keep your identity anonymous with the researcher for this phase of the study. However, please use your login identity when you upload the completed form, so that Dr. Brophy will know who turned in the assignment.

Part 1: Creating Questions

For part 1, you will create questions within particular topic areas (there are eight) that you would like to see asked regarding your experience and/or feelings about an online course you might be taking. Similar to the way students provide their instructors feedback at the end of a course, we want you to create questions that could be used for any online course to capture your experience, but only for W or M type courses at UCF.

The questions you create are intended to be used to ask your peers about their experiences with online instruction and learning courses. Your contributions will be merged with the contributions provided by other study volunteers. We ask that you spend sufficient time to carefully consider your questions and their wording. Try to be clear and to the point. If a question seems long or complex, make it into two questions instead. Try to imagine how someone else might read and interpret your questions.

Below are eight specific areas that have been shown to be important to students who take online courses. Each area includes some general descriptions about the area, which should provide you with an orientation sufficient for you to create your own questions and to complete the exercise.

For each of the eight areas, please write a minimum of two (2) questions that you would want to see asked regarding your experience with an online course you would be taking. You are free to write more than two questions.

You may choose whatever form of question that you wish: examples can include True/False, Multiple Choice, Scaled or Likert (e.g., 0-10, Strongly Disagree-Strongly Agree, Really Dislike-Really Like, etc), or open-ended. Please include the details of how the students should answer, or they choices they would have, if the question form is not open-ended.

Use your mouse and click in the grayed areas to enter your responses.

Area 1: Reducing ambiguity

Students want to see…

- Reduced uncertainty about how to succeed in course
- Reduced work and family disruption and constraints
- Improved sense of control

Suggestion: You might want to phrase your questions on topics about what would make an online course difficult or easy to succeed as you begin and proceed through to the end.

Your questions:

Area 2: Enhancing sense of course value

Students want to see…

- Faster assessment of assignments
- Higher levels of recognition
- Better able to audit course progress

Suggestion: You might want to phrase your questions on topics about what would make an online course personally more valuable to you, and help you take ownership of how well you do.

Your questions:

Area 3: Reducing ambivalence (or improving how the course matters to you)

Students want to see…

- Reduced stress over course completion
- Increased degree of course access
- Increased connectedness

Suggestion: You might want to phrase your questions on topics about what would make taking and completing an online course meaningful to you, rather than only fulfilling a requirement.

Your questions:

Area 4: Clarifying engagement or expectations

Students want to see…

- Course expectations clear from the onset
- Fairer performance assessment
- Clearer definition of involvement
- More opportunity to collaborate

Suggestion: You might want to phrase your questions on topics about what would help you to plan what you will need to do to succeed when you take an online course.

Your questions:

Area 5: Integrating individually responsive learning environments

Students want to see they are…

- Continually connected as an individual
- Encouraged to be actively engaged
- Facilitated access to outside sources
- Able to audit course progress

Suggestion: You might want to phrase your questions on topics about what would motivate you to stay involved and active when you take an online course.

Your questions:

Area 6: Improving interactions

Students want to see…

- Anywhere, anytime communication with peers
- Anywhere, anytime queries to instructors
- Sustained conversations
- Rapid access to independent experts
- Better able to find, evaluate, and use information (information fluency)

Suggestion: You might want to phrase your questions on topics about what would engage you through interactions with the instructor(s), fellow students, people outside the course, materials (such as books, articles, etc), tools (such as computer programs, lab equipment, web sites, etc), or environments (such as physical environments, virtual environments such as discussion boards, chat rooms, facebook, or other areas where you find interacting easy to do) when you take an online course.

Your questions:

Area 7: Augmenting learning

Students want to see…

- More room for individual creativity
- More individual empowerment to learn
- Expanded course boundaries

Suggestion: You might want to phrase your questions on topics about what would motivate you to go beyond set expectations when you take an online course.

Your questions:

Area 8: Increasing freedom (latitude)

Students want to see…

- Self-managing the learning environment
- Expanding beyond the current course
- Alternatives to large lecture classes
- Reducing prohibitive logistics

Suggestion: You might want to phrase your questions on topics about what could be done in an online course to make your learning experience better balance with your other responsibilities.

Your questions:

Part 2: Taking a Researcher's Role

For part 2, the assignment is to have you temporarily step into the role of a researcher for this study. While we realize you will likely not have very much experience conducting research, your perspective is still quite valuable. We want you to think about the best ways to work with you and your peers on a study of student perception of online instruction and learning. If you were trying to gather students' perspectives, how would you do it differently? What would you change? What should researchers know that would better prepare them to study students' perception of online instruction and learning? This section is open to you to express how you might change studying this topic.

Consider the questions below and provide your responses. We will use your ideas and discuss them in the focus group. If there is a question you do not wish to answer, please enter "N/A" in the box.

As a researcher designing this study…

1: What would you change?

Your response:

2: How would you use the eight areas you worked with in Part 1? How would you change any of these?

Your response:

3: How would you collect the data from student volunteers?

Your response:

4: How would you analyze and process the data?

Your response:

5: When the questions are complete so a questionnaire can be given to students, when is an appropriate time to make it available for students taking an online course?

Your response:

6: Who else would you involve in the study?

Your response:

Final Instructions: Submitting Your Contributions

Now that you have completed this assignment, please **SAVE** it to your computer and then **UPLOAD** it into the Webcourses assignment tool, *Study Project - Student Perception of Online Instruction*, by 3:00pm, November 21, 2008.

Your contributions will be merged with the other study participants, and the results will be returned to you two more times for your review and editing. During the second and third reviews, you will be instructed to consider the additional viewpoints of other volunteers and to select the two for each area you find the most important.

Thank you again for volunteering to support this study. Your contributions are very valuable.

APPENDIX C: STUDENT SOLICITATION MESSAGE

The following is the solicitation message distributed through the ALN to students. Some variations of this message were made to accommodate specific requests of hosting instructions, such as indications that the survey was not required and that the message was provided with their explicit permission.

Dear Students,

When you take an online course, and you really have to work hard to learn the material, do you find the challenge satisfying?

Please take this online survey - http://tinyurl.com/ykjmt5t - it has about 24 questions and should take only 10-15 minutes.

You will change how we design online courses – Please participate!

-George Bradford

Center for Distributed Learning, UCF

APPENDIX D: PILOT SURVEY INSTRUMENT

The following is the print version of the original electronic pilot instrument.

Student Satisfaction in Online Learning - Pilot

Dear Student,

What is this survey about?
When you take a course online and there are times when the material is really difficult, how do you react to the different media that is intended to help you learn?

Can you participate?
First, you must be 18 years or older. And second, you need to have had at least one online course, either type M (mixed mode or blended – when you sometimes meet face-to-face with your instructor and fellow classmates) or type W (completely online – when you never have any face-to-face meetings).

How long does it take?
It will probably take about 10 to 15 minutes to answer all the questions. The more honest information you give us about your experience, the better we will learn how to design online courses that work for you.

Getting started…
During this study, you will not be required to answer any questions you do not wish to answer, with the exception of a single question regarding your age – this must be answered, as you must be at least 18 years of age to participate. You may quit the questionnaire at any time.

Please read each statement carefully before selecting your response. Do not enter your name anywhere within this questionnaire. This is to keep your identity anonymous with the researcher. Selecting the ***Next*>>** button below indicates your consent to participate in this study.

As you respond to the statement items, reflect on one particular online course you had and respond to all statements in the survey while considering that experience.

Who's the researcher?
George Bradford. I work for Course Development and Web Services at UCF. This is my doctoral dissertation research. You can contact me at (407) 823-3718, or by email: gbradfor@mail.ucf.edu.

Thank you!
You are choosing to make a difference because your responses will help online faculty and support personnel to understand what students look for in online instruction at UCF. So, *thank you* for participating in this study!

University Research Legal Stuff
There are no anticipated risks, compensation, or other direct benefits to you as a participant. Your responses will be combined with those who participate in this questionnaire for analyses.

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed to the Institutional Review Board Office, IRB Coordinator, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The telephone number is (407) 823-2901.

This survey is designed to collect data regarding the experiences students have with learning online courses. Specifically, the intent is to capture data to determine if there are relationships between cognitive load and the learning context.

There are 30 questions in this survey

Cognitive Load

1 For *all* statement items in this survey, consider or refer to the online course you are currently enrolled in (or select one that stands out in your mind) when you respond.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The instructor relied heavily on visual materials.	○	○	○	○	○
More material should be presented in an audio format (e.g., verbal recordings).	○	○	○	○	○

2 I am satisfied with the instructor's heavy emphasis on visual materials.

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was 'Agree' or 'Strongly agree' at question '1 [cogLoad_typ1]' (For all statement items in this survey, consider or refer to the online course you are currently enrolled in (or select one that stands out in your mind) when you respond. (The instructor relied heavily on visual materials.))

-------- or Scenario 2 --------

Answer was 'Agree' or 'Strongly agree' at question '1 [cogLoad_typ1]' (For all statement items in this survey, consider or refer to the online course you are currently enrolled in (or select one that stands out in your mind) when you respond. (More material should be presented in an audio format (e.g., verbal recordings).))

Please choose only one of the following:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

3

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I think the use of audio in this course was excessive.	○	○	○	○	○
I think the use of text-based materials in this course was excessive.	○	○	○	○	○

4 I am satisfied with the instructor's heavy use of audio or text-based materials.

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was 'Strongly agree' or 'Agree' at question '3 [cogLoad_typ2]' ((I think the use of audio in this course was excessive.))

-------- or Scenario 2 --------

Answer was 'Strongly agree' or 'Agree' at question '3 [cogLoad_typ2]' ((I think the use of text-based materials in this course was excessive.))

Please choose only one of the following:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

5

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The instructor used material in this online course that I did not think was relevant to understanding critical concepts.	○	○	○	○	○
In some instances, critical information was presented as multimedia when a simple text document would have been better.	○	○	○	○	○

6 I am satisfied with the instructor's selection of material.

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was 'Strongly agree' or 'Agree' at question '5 [cogLoad_typ3]' ((The instructor used material in this online course that I did not think was relevant to understanding critical concepts.))

-------- or Scenario 2 --------

Answer was 'Strongly agree' or 'Agree' at question '5 [cogLoad_typ3]' ((In some instances, critical information was presented as multimedia when a simple text document would have been better.))

Please choose only one of the following:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

7

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I could not understand how to use some material that was included in this online course.	○	○	○	○	○
I found that information critical for understanding key concepts was located in many different places.	○	○	○	○	○

8 I am satisfied with my ability to learn how to use the material included in the course.

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was 'Strongly agree' or 'Agree' at question '7 [cogLoad_typ4]' ((I could not understand how to use some material that was included in this online course.))

-------- or Scenario 2 --------

Answer was 'Strongly agree' or 'Agree' at question '7 [cogLoad_typ4]' ((I found that information critical for understanding key concepts was located in many different places.))

Please choose only one of the following:

- ○ Strongly agree
- ○ Agree
- ○ Neutral
- ○ Disagree
- ○ Strongly disagree

9

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I believe that to learn this material successfully, I must work with a large number of facts and concepts.	○	○	○	○	○
I believe that I am able to retain a large number of facts and concepts.	○	○	○	○	○

10 I am satisfied with my ability to work in a course where I have to manage a lot of new facts and concepts.

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was 'Strongly agree' or 'Agree' at question '9 [cogLoad_typ5]' ((I believe that to learn this material successfully, I must work with a large number of facts and concepts.))

-------- or Scenario 2 --------

Answer was 'Strongly agree' or 'Agree' at question '9 [cogLoad_typ5]' ((I believe that I am able to retain a large number of facts and concepts.))

Please choose only one of the following:

○ Strongly agree

○ Agree

○ Neutral

○ Disagree

○ Strongly disagree

11 Please comment on when you get overloaded (cognitively) in a course and how you deal with it.

Please write your answer here:

Context of Learning

12

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I found that the syllabus and the assignments clearly indicated what I needed to do in this online course.	○	○	○	○	○
I was able to effectively locate answers to my questions about this online course.	○	○	○	○	○
I found that I was able to track my progress in the course effectively.	○	○	○	○	○
I feel that the instructor's feedback, advice, or guidance in this course was effective.	○	○	○	○	○

13

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I can see how what I learn in this course is	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
relevant to my major field of study.					
I found that I was able to communicate with everyone who was part of this online course effectively.	○	○	○	○	○
I found that the assessments accurately reflect my level of understanding for the course topics.	○	○	○	○	○
I prefer that my instructor have both in person office hours and online office hours, so I can talk about concerns, problems, or grades.	○	○	○	○	○

14

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was motivated to participate in the online activities.	○	○	○	○	○
I found that activities following a routine, such as weekly, quizzes, readings, or discussions, kept me involved in my online class.	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I think actively communicating, discussing, or debating is necessary for online courses to achieve maximum effectiveness.	○	○	○	○	○
I believe being respectful in online communications is necessary for effective interactions.	○	○	○	○	○

15

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was motivated to go beyond the required assignments in this online course.	○	○	○	○	○
For graded assignments, I prefer being able to choose from different assignment options.	○	○	○	○	○
I felt the course provided enough opportunities for me to develop my own solutions to assignment tasks.	○	○	○	○	○
I prefer individually assigned due dates for assignments, rather than an "all due at the	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
end of the semester" approach.					

16 Please comment on what it takes for you to be satisfied with an online course.

Please write your answer here:

General Satisfaction

17

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Overall, I am satisfied with this online course.	○	○	○	○	○

Student Demographics

18 Age (you must be 18 years or older to participate): *

Please write your answer here:

19 Marital status:

Please choose the appropriate response for each item:

	Significant other/married	Divorced	Single
Marital status:	○	○	○

20 Academic standing:

Please choose the appropriate response for each item:

	Freshman	Sophomore	Junior	Senior	Graduate	Other
Currently:	○	○	○	○	○	○

21 Gender:

Please choose only one of the following:

○ Female

○ Male

22 How many children live at home?

Please write your answer here:

23 Hours employed (per week):

Please write your answer here:

24 Ethnicity:

Please choose the appropriate response for each item:

	African American	Asian Pacific Islanders	Non-Hispanic White	Hispanic	Native American	Other
Ethnicity:	○	○	○	○	○	○

Student Online Experience

25 Including courses you are taking this semester, how many blended (M) online courses have you taken?

Please write your answer here:

26 Including courses you are taking this semester, how many fully online (W) courses have you taken?

Please write your answer here:

27 What do you find to be the strengths of online courses?

Please write your answer here:

28 What do you find to be the weaknesses of online courses?

Please write your answer here:

Pilot Evaluation

29 Please respond to the following statements to tell us about how you perceived this survey.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I found the questionnaire items easy to read.	○	○	○	○	○
I understood all of the questionnaire items.	○	○	○	○	○
I did not find any problems with the questionnaire items.	○	○	○	○	○
Responding to the items was easy.	○	○	○	○	○

30 Do you have any suggestions for improving this questionnaire? We will take your suggestions seriously.

Please write your answer here:

Submit your survey.
Thank you for completing this survey.

APPENDIX E: FINAL SURVEY INSTRUMENT

The following is the print version of the original electronic instrument used for the final data collection.

Student Satisfaction in Online Learning

Dear Student,

What is this survey about?
We are trying to learn how satisfied you feel after putting in a lot of mental effort to learn in an online course.

Can you participate?
First, you must be 18 years or older. And second, you need to have had at least one online course, either type M (mixed mode or blended – when you sometimes meet face-to-face with your instructor and fellow classmates) or type W (completely online – when you never have any face-to-face meetings).

How long does it take?
It will probably take about 10 to 15 minutes to answer all 24 questions.

With your honest replies, we will learn how to design online courses that work better for you.

Getting started…
During this study, you will not be required to answer any questions you do not wish to answer – with the exception of the question regarding your age. You may quit the questionnaire at any time.

Please read each statement carefully before selecting your response.

Do not enter your name anywhere within this questionnaire. This is to keep your identity anonymous.

Selecting the **Next>>** button below indicates your consent to participate in this study.

Who's the researcher?
George Bradford. I work for the Center for Distributed Learning at UCF. This is part of my doctoral dissertation. You can contact me at (407) 823-3718, or by email: gbradfor@mail.ucf.edu.

Thank you!
You will make a difference because your responses help online faculty and support personnel to understand what students look for in online instruction. *Thank you* for participating in this study!

University Research Legal Stuff
There are no anticipated risks, compensation, or other direct benefits to you as a participant. Your responses will be combined with those who participate in this questionnaire for analyses.

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed to the Institutional Review Board Office, IRB Coordinator, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246. The telephone number is (407) 823-2901.

This survey is designed to collect data regarding the experiences students have with learning online courses. Specifically, the intent is to capture data to determine if there are relationships between cognitive load and the learning context.

There are 24 questions in this survey

Cognitive Load

1) Consider the following situation in an online course.

The material to learn is difficult, there is a lot of material to learn, and it is all visual (i.e., it is all text or graphics).

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.1) I would be satisfied when the material is only presented in visual formats.	○	○	○	○	○
1.2) I would be satisfied when some of the visual material is presented instead in an audio format (e.g., verbal recordings).	○	○	○	○	○

2) Consider the following situation in an online course.

The material to learn is difficult, there is a lot of material to learn, and it is all presented with visual (such as using text or graphics) and audio (such as using verbal recordings) materials.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
2.1) I would be satisfied when the material is presented in visual and audio	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
formats.					
2.2) I would be satisfied when the material is presented instead with time between segments.	○	○	○	○	○
2.3) I would be satisfied when I have had some pre-training to prepare me for the material.	○	○	○	○	○

3) Consider the following situation in an online course.

The material to learn is difficult, there is a lot of material to learn, and I find that some of the material is extra, or not really necessary.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
3.1) I would be satisfied when the material includes extra content.	○	○	○	○	○
3.2) I would be satisfied when the extra material is removed.	○	○	○	○	○
3.3) I would be satisfied when I receive instruction on how to use the extra material.	○	○	○	○	○

4) Consider the following situation in an online course.

The material to learn is difficult, there is a lot of material to learn, and I find the presentation of the material

is confusing (i.e., not the content, but how the content is presented).

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
4.1) I would be satisfied if the presentation of the material is confusing.	○	○	○	○	○
4.2) I would be satisfied when visual materials are organized to reduce scanning for corresponding information.	○	○	○	○	○
4.3) I would be satisfied when duplicated information is removed from the presentation (e.g., when the same information is presented in audio and visual formats).	○	○	○	○	○

5) Consider the following situation in an online course.

The material to learn is difficult, there is a lot of material to learn, and I find the material requires I have to keep a lot in my head (i.e., memory) to understand it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
5.1) I would be satisfied if the presentation of the material requires that I keep a lot in memory.	○	○	○	○	○
5.2) I would be satisfied if the presentation of the	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
material is better organized to reduce having to keep a lot in memory.					
5.3) I would be satisfied if the presentation of the material requires I keep a lot in memory as long as I am trained to be able to do this.	○	○	○	○	○

6) Please describe a situation in an online course when you feel you are *overloaded* (cognitively) and how you react to it.

Please write your answer here:

Context of Learning

7) Consider the following situation in an online course and then react to the statements.

The material to learn is difficult, there is a lot of material to learn, and I had to put in a lot of effort to learn it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
7.1) I find that the syllabus and assignment descriptions must clearly indicate what I need to do for me to be successful in an online course.	○	○	○	○	○
7.2) I believe that being able to easily find answers to my	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
questions about an online course is critical to my success.					
7.3) I find it is critical to my success that I am able to track my progress in an online course.	○	○	○	○	○
7.4) I feel that I require an instructor's feedback, advice, or guidance in an online course to be successful.	○	○	○	○	○

8) Consider the following situation in an online course and then react to the statements.

The material to learn is difficult, there is a lot of material, and I had to put in a lot of effort to learn it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
8.1) To be successful, I need to see how what I learn in an online course is relevant to my major field of study.	○	○	○	○	○
8.2) I need to be able to communicate with everyone who is part of an online course.	○	○	○	○	○
8.3) I find that I need to be assessed (i.e., tested or given feedback) often to know how I am doing in the course.	○	○	○	○	○

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
8.4) I prefer that my instructor only has online office hours, where I can communicate my concerns, problems, or grades.	○	○	○	○	○

9) Consider the following situation in an online course and then react to the statements.

The material to learn is difficult, there is a lot of material, and I had to put in a lot of effort to learn it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
9.1) To be successful, I need to be motivated to participate in online course activities.	○	○	○	○	○
9.2) I need activities that follow a routine, such as weekly quizzes, readings, or discussions, to keep me engaged in my online class.	○	○	○	○	○
9.3) I believe actively communicating, discussing, or debating is necessary for online courses to be effective.	○	○	○	○	○
9.4) I believe that for interactions to be effective in online communications, it is important to be respectful.	○	○	○	○	○

10) Consider the following situation in an online course and then react to the statements.

The material to learn is difficult, there is a lot of material, and I had to put in a lot of effort to learn it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
10.1) I always want to go beyond the required assignments in an online course.	○	○	○	○	○
10.2) For graded assignments, I need to have options to be successful in an online course.	○	○	○	○	○
10.3) I feel a course needs to provide me with opportunities to develop my own solutions to assignment tasks.	○	○	○	○	○
10.4) I need to have assigned due dates through the study term, rather than an "all due at the end of the semester" approach.	○	○	○	○	○

11) Please comment on anything else that is important for you to be satisfied with an online course.

Please write your answer here:

General Satisfaction

12) Consider the following situation in an online course and then react to the statements.

The material to learn is difficult, there is a lot of material, and I am challenged with the situation.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
12.1) I look for the potential of reward when I must learn difficult course material in an online course.	○	○	○	○	○
12.2) I set my goals based on future satisfaction.	○	○	○	○	○
12.3) I find that when I am challenged in an online course, satisfaction is its own reward.	○	○	○	○	○
12.4) I find myself more satisfied when an online course is difficult than when it is not.	○	○	○	○	○

13) Consider the following situation in an online course and then react to the statement.

The material to learn is difficult, there is a lot of material, and I had to put in a lot of effort to learn it.

Please choose the appropriate response for each item:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
13.1) Overall, I am generally satisfied when I have to put in a lot of effort to learn.	○	○	○	○	○

Student Demographics

14) My age is (you must be 18 years or older to participate): *

Please write your answer here:

15) My marital status is:

Please choose the appropriate response for each item:

	Significant other/married	Divorced	Single
Marital status:	○	○	○

16) My academic standing is:

Please choose the appropriate response for each item:

	Freshman	Sophomore	Junior	Senior	Graduate	Other
Currently:	○	○	○	○	○	○

17) I am (gender):

Please choose only one of the following:

○ Female

○ Male

18) How many children live at home?

Please write your answer here:

19) Hours employed (per week):

Please write your answer here:

20) My ethnicity is:

Please choose the appropriate response for each item:

	African American	Asian Pacific Islanders	Non-Hispanic White	Hispanic	Native American	Other
Ethnicity:	○	○	○	○	○	○

Student Online Experience

21) Including courses you are taking this semester, how many blended (M) online courses have you taken?

Please write your answer here:

22) Including courses you are taking this semester, how many fully online (W) courses have you taken?

Please write your answer here:

23) What do you find to be the strengths of online courses?

Please write your answer here:

24) What do you find to be the weaknesses of online courses?

Please write your answer here:

Submit your survey.
Thank you for completing this survey.

APPENDIX F: IRB AUTHORIZATION LETTERS

The following is an image of the initial IRB authorization letter regarding this research study.

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 10/8/11, IRB00001138

To : **George R Bradford, Charles D. Dziuban, Patsy D. Moskal**

Date : **November 10, 2008**

IRB Number: **SBE-08-05873**

Study Title: **Student Perception of Online Instruction and Learning: Exploring the Dziuban Model**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Vice-chair on 11/6/2008. **The expiration date is 11/5/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 11/10/2008 02:09:07 PM EST

IRB Coordinator

The following is the follow-on IRB authorization letter that covers the final portion of this research study.

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **George Bradford** and Co-PIs: **Charles D. Dziuban, Patsy D. Moskal**

Date: **October 15, 2009**

Dear Researcher:

On 10/15/2009, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review: Exempt Determination
Project Title: Student Perception of Online Instruction and Learning: Exploring the Dziuban Model
Investigator: George Bradford
IRB Number: SBE-08-05873
Funding Agency:
Grant Title:
Research ID: N/A

At the time of this Continuing Review, it was determined that your study meets Exempt Category # 2. Therefore, the study no longer has an expiration date. In addition, you are not required to use an Informed Consent document, but as with all human research, you need to follow your consent process with research participants. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. **When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.**

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 10/15/2009 11:07:36 AM EDT

Joanne Muratori

IRB Coordinator

APPENDIX G: RELIABILITY ANALYSIS OF ALL SCALES

In Table 24, the results of the Reliability Analysis are combined into a single scale.

Table 24

Reliability Analysis of All Scales (based on standardized items, α = .8)

Item	Cronbach's Alpha if item deleted
Cognitive Load	
1.1) Use visual only formats	.8
1.2) Replace some visual with audio	.8
2.1) Use both visual and audio	.8
2.2) Separate segments with time	.8
2.3) Prepare with pre-training	.8
3.1) Include extra material	.8
3.2) Remove extra material	.8
3.3) Instruct how to use extra material	.8
4.1) Use of confusing material is ok	.8
4.2) Organize visual materials to reduce scanning	.8
4.3) Do not duplicate material in alternate modalities	.8
5.1) Presentation requiring high memory is ok	.8
5.2) Organize presentation to reduce high memory	.8
5.3) Train to manage high memory presentations	.8
Satisfaction: Sloan Model	
7.1) Clear directions in syllabus and assignments	.8
7.2) Easy to find answers	.8
7.3) Be able to track progress	.8
7.4) Require instructor's feedback, advice, or guidance	.8
8.1) See relevance to major field of study	.8
8.2) Be able to communicate with others in course	.8
8.3) Need to be assessed often	.8
8.4) Instructor only has online office hours	.8
9.1) Need to be motivated to participate	.8
9.2) Need routine activities to keep engaged	.8
9.3) Believe active communications, discussions, or debates are necessary	.8
9.4) Believe communications must be respectful	.8
10.1) Want to go beyond required assignments	.8
10.2) Need assignment options	.8
10.3) Need opportunities to develop own solutions for assignments	.8
10.4) Need due dates throughout course, not all due at end	.8

Item	Cronbach's Alpha if item deleted
Satisfaction: Goals and Rewards	
12.1) Look for potential reward	.8
12.2) Set goals based on future satisfaction	.8
12.3) When challenged, satisfaction is its own reward	.8
12.4) More satisfied when more challenged	.8
13.1) Overall, more satisfied when I put in a lot of effort	.8

APPENDIX H: RESULTS OF IMAGE ANALYSIS

Table 25 presents the results of the Image Analysis. Assuming a value of .40 for salient pattern coefficients from the image analysis table, and identifying all items with equal or greater to that minimum value, produced the underlying components across three groups. In the Image Analysis, the third construct results in a single factor, which is disallowed. Another factor does not emerge until the value for salient pattern coefficients is set to .20. The three factors identified and kept for the rotation converged after six iterations.

Table 25

Factor Analysis - Image - Pattern Matrix(a)

Factors Item	Awareness	Challenge	Engagement
Be able to track progress (7.3)	.65		
Easy to find answers (7.2)	.57		
Clear directions in syllabus and assignments (7.1)	.55		
Believe communications must be respectful (9.4)	.48		
Organize presentation to reduce high memory (5.2)	.47		
Require instructor's feedback, advice, or guidance (7.4)	.47		
Use of confusing material is ok (4.1)		.49	
Presentation requiring high memory is ok (5.1)		.48	
Want to go beyond required assignments (10.1)		.48	
More satisfied when more challenged (12.4)		.47	
Believe active communications, discussions, or debates are necessary (9.3)		.42	
Include extra material (3.1)			.56

Extraction Method: Image Factoring. Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

In Table 26, the correlation between factors is presented for the image analysis.

Table 26

Factor Correlation Matrix - Image Analysis

Factor	Awareness	Challenge	Engagement
Awareness	-		
Challenge	.24	-	
Engagement	-.17	.34	-

Extraction Method: Image Factoring. Rotation Method: Promax with Kaiser Normalization.

LIST OF REFERENCES

Abrahamson, C. E. (1998). Issues in interactive communication in distance education. *College Student Journal, 32*, 33-42.

Allen, I. E., & Seaman, J. (2007). *Online nation: Five years of growth in online learning*. Orlando, FL: Alfred P. Sloan Foundation.

Alliger, G. M., & Janak, E. A. (1994). Kirkpatrick's levels of training criteria: Thirty years later. In C. E. Schneier, C. J. Russell, R. W. Beatty & L. S. Baird (Eds.), *The training and development sourcebook* (pp. 219-227). Amherst, MA: HRD Press.

Alliger, G. M., Tannenbaum, S. I., Bennett JR., W., Traver, H., & Shotland, A. (1997). A meta-analysis of the relations among training criteria. *Personnel Psychology, 50*(2), 341-358. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=9708176064&site=ehost-live

Andres, H. P. (2004). Multimedia, information compexity, and cognitive processing. *Information Resources Management Journal, 17*(1), 63-78.

Ary, D., Jacobs, L. C., & Razavieh, A. (1990). *Introduction to research in educatio*n (4th ed.). Orlando, FL: Harcourt Brace Jovanovich, Inc.

Ashcraft, M. H. (1994). *Human memory and cognitio*n (2nd ed.). New York, NY: John Wiley & Sons, Inc.

Astin, A. W. (1993). *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher educatio*n. Phoenix, Az: Oryx Press.

Astleitner, H., & Wiesner, C. (2004). An integrated model of multimedia learning and motivation. *Journal of Educational Multimedia and Hypermedia, 1*3(1), 3-22.

Baddeley, A. D. (1986). *Working memory: Theory and practice*. London, UK: Oxford University Press.

Baddeley, A. D. (2001). Is working memory still working*? American Psychologist, 56*(11), 851-864.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*(2), 122-147.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bates, R. (2004). A critical analysis of evaluation practice: The kirkpatrick model and the principle of beneficence. *Evaluation and Program Planning, 27*(3), 341-347.

Beile, P. M., Boote, D. N., & Killingsworth, E. K. (2004). A microscope or a mirror?: A question of study validity regarding the use of dissertation citation analysis for evaluating research collections. *The Journal of Academic Librarianship, 30*(5), 347-353.

Berlyne, D. E. (1964). Emotional aspects of learning. *Annual review of psychology: XV*. (pp. 115-142). Oxford England: Annual Reviews. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=1965-06301-007&site=ehost-live

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L., Wallet, P. A., Fiset, M., & Huang, B. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379.

Biggs, J. (1999). *Teaching for quality learning at university*. Oxford, UK: Oxford University Press.

Blumenfeld, P. C. (1992). Classroom learning and motivation: Clarifying and expanding goal theory. *Journal of Educational Psychology, 84*(3), 272-281.

Boote, D. N., & Beile, P. (2005). Scholars before researchers: On the centrality of the dissertation literature review in research preparation. *Educational Researcher, 34*(6), 3.

Brennan, R. L. (2001). *Generalizability theory*. New York, NY: Springer Verlag.

Brinkerhoff, R. (1988). An integrated evaluation model for HRD. *Training and Development Journal, 42*(2), 66-68.

Bruning, R. H., Schraw, G. J., Norby, M. M., & Ronning, R. R. (2004). *Cognitive psychology and instruction*. (Fourth Edition ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Brunken, R., Plass, J. L., & Leutner, D. (2003). Direct measurement of cognitive load in multimedia learning. *Educational Psychologist, 38*(1), 53-61. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9110439&site=ehost-live

Capan, L. A., Lambert, J., & Kalyuga, S. (2009). Student perceptions and cognitive load: What can they tell us about e-learning web 2.0 course design? *E-Learning,* 6(2), 150-163.

Cattell, R. B. (1966). The scree test for the number of factors 1. *Multivariate Behavioral Research,* 1(2), 245-276. doi:10.1207/s15327906mbr0102_10

Cennamo, K. S. (1993). Learning from video: Factors influencing learners' preconceptions and invested mental effort. *Educational Technology Research and Development, 41*(3), 33-45.

Chickering, A. W., & Ehrmann, S. C. (1996). Implementing the seven principles: Technology as lever. *AAHE BULLETIN, 49*, 3-6.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin, 39*(7), 3-7.

Clark, R. E., Yates, K., Early, S., & Moulton, K. (In press). An analysis of the failure of electronic media and discovery-based learning: Evidence for the performance benefits of guided training methods. In K. H. Silber, & R. Foshay (Eds.), *Handbook of training and improving workplace performance, volume I: Instructional design and training deliver*y (). Somerset, NJ: Wiley.

Clark, R. C., & Mayer, R. E. (2007). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learnin*g (2nd ed.). San Francisco, CA: Pfeiffer.

Clark, R. E. (1999). Yin and yang cognitive motivational processes operating in multimedia learning environments. In J. J. G. Van Merrienboer (Ed.), *Cognition and multimedia desig*n (pp. 1-38). Herleen, Netherlands: Open University Press.

Clark, R. E. (2001). In Clark R. E. (Ed.), *Learning from media: Arguments, analysis, and evidenc*e. Greenwich, CT: Information Age Publishing.

Clark, R. E., & Feldon, D. F. (2005). Five common but questionable principles of multimedia learning. In R. E. Mayer (Ed.), *The cambridge handbook of multimedia learnin*g (pp. 97-115). New York, NY: Cambridge University Press.

Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational consideration*s (pp. 1-46). New York, NY: Cambridge University Press.

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: A meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology, 85*(5), 678-707.

Cook, A. E., Zheng, R. Z., & Blaz, J. W. (2009). Measurement of cognitive load during multimedia learning activities. In R. Z. Zheng (Ed.), *Cognitive effects of multimedia learning* (pp. 34-50). Hershey, PA: Information Science Reference.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences, 24*(01), 87-114.

De Corte, E. (2000). Marrying theory building and the improvement of school practice: A permanent challenge for instructional psychology. *Learning and Instruction, 10*(3), 249-266. doi:DOI: 10.1016/S0959-4752(99)00029-8

DeCharms, R. (1968). *Personal causation*. New York, NY: Academic Press.

Deci, E. L. (1975). *Intrinsic motivation*. New York, NY: Plenum Press.

Deubel, P. (2003). An investigation of behaviorist and cognitive approaches to instructional multimedia design. *Journal of Educational Multimedia and Hypermedia, 12*(1), 63-90.

Dick, W., & Johnson, R. B. (2002). Evaluation in instructional design: The impact of Kirkpatrick's four-level model. In R. A. Reiser, & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp. 145-153). Upper Saddle River, NJ: Pearson Education, Inc.

Dillman, D. A. (2006). *Mail and internet surveys: The tailored design method* (Second ed.). Hoboken, NJ: John Wiley & Sons Inc.

Dubuc, B. (February, 2009). *The brain from top to bottom*. Retrieved July 25, July, 2009, from http://thebrain.mcgill.ca/flash/index_a.html

Dziuban, C., Hartman, J., Moskal, P. D., Brophy-Ellison, J., & Shea, P. (2007). *Student involvement in online learning*. Orlando, FL: Sloan Center for Online Education.

Dziuban, C., Moskal, P., Brophy-Ellison, J., & Shea, P. (2007). Technology-enhanced education and millennial students in higher education. *Metropolitan Universities, 18*(3), 75-90.

Dziuban, C., Moskal, P. D., Bradford, G. R., Brophy-Ellison, J., & Groff, A. (2010). Constructs that influence net generation satisfaction with online learning. In R. Sharpe, H. Beetham & S. De Freitas (Eds.), *Rethinking learning for a digital age: How learners are shaping their own experiences* (). New York, NY: Routledge / Taylor & Francis.

Ehrmann, S. C., & Zuniga, R. E. (1997). *The flashlight evaluation handbook*. Washington, DC: Teaching, Learning, and Technology Group.

Ericsson, K. A., Chase, W. G., & Faloon, S. (1980). Acquisition of a memory skill. *Science, 208*, 1181-1182.

Feldon, D. F. (2007a). Cognitive load and classroom teaching: The double-edged sword of automaticity. *Educational Psychologist, 42*(3), 123-137. doi:10.1080/00461520701416173

Feldon, D. F. (2007b). The implications of research on expertise for curriculum and pedagogy. *Educational Psychology Review, 19*(2), 91-110.

Garrison, D. R., & Akyol, Z. (2009). Role of instructional technology in the transformation of higher education. *Journal of Computing in Higher Education, 21*(1), 19-30.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York, NY: Aldine Publishing Company.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for likert-type scales. Paper presented at the *2003 Midwest Research-*

to-Practice Conference in Adult, Continuing, and Community Education, Columbus, Ohio : Ohio State University. 82-88.

Gorsuch, R. L. (1983). *Factor analysi*s (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Grant, M. R., & Thornton, H. R. (2007). Best practices in undergraduate adult-centered online learning: Mechanisms for course design and delivery. *Journal of Online Learning and Teaching, 3*(4), 346-356.

Greene, R. (1992). *Human memory: Paradigms and paradoxes*. Mahwah, NJ: Lawrence Erlbaum Associates.

Gustafson, K. L., & Branch, R. M. (2002). What is instructional design? In R. A. Reiser, & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp. 16-25). Columbus, OH: Merrill-Prentice Hall.

Guttman, L. (1953). *Two new approaches to factor analysis* No. Nonr-731 (00)). Washington, DC: Office of Naval Research.

Guttman, L. (1955). The determinacy of factor score matrices with implications for five other basic problems of common-factor theory. *British Journal of Statistical Psychology, 8*, 65-81.

Hamblin, A. C. (1974). Evaluation and control of training. *Industrial Training International, 9*(5), 154-156.

Harman, H. H. (1967). *Modern factor analysis* (Second ed.). Chicago, Il: University of Chicago Press.

Hart, C. (1998). *Doing a literature review: Releasing the social science research imagination*. Thousand Oaks, CA: Sage.

Hartley, K. W. (1999). Media overload in instructional web pages and the impact on learning. *Educational Media International, 36*(2), 145-150.

Hickey, D. T. (1997). Motivation and contemporary socio-constructivist instructional perspectives. *Educational Psychologist, 32*(3), 175-193.

Hirumi, A. (2005). *ARCS model of motivational design: Workshop materials.* Unpublished manuscript.

Hjorland, B. (1988). Information retrieval in psychology: Implications of a case study. *Behavioral and Social Sciences Librarian, 6*(3-4), 39-64.

Holton, E. (1996). The flawed four-level evaluation model. *Human Resource Development Quarterly, 7*(1), 5-22.

Huang, W., Huang, W., Diefes-Dux, H., & Imbrie, P. K. (2006). A preliminary validation of attention, relevance, confidence and satisfaction model-based instructional material motivational survey in a computer-based tutorial setting. *British Journal of Educational Technology, 37*(2), 243-259.

Hull, C. L. (1943). *Principles of behavior: An introduction to behavior theory*. New York, NY: D. Appleton-Century Company, Inc.

Irlbeck, S., Kays, E., Jones, D., & Sims, R. (2006). The phoenix rising: Emergent models of instructional design. *Distance Education, 27*(2), 171-186.

Järvelä, S. (2007). Shifting research on motivation and cognition to an integrated approach on learning and motivation in context. In S. Volet, & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical and methodological implications* (1st ed., pp. 1). Kidlington, Oxford: UK: Elsevier Science Ltd.

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

Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of Applied Psychology, 74*(4), 657-690.

Kaplan, A. (1964). *The conduct of inquiry*. San Francisco, CA: Chandler.

Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Learning, Media and Technology, 29*(3), 229-239.

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (First ed., pp. 386-434). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Keller, J. M. (1987a). Strategies for stimulating the motivation to learn. *Performance and Instruction, 26*(8), 1-7.

Keller, J. M. (1987b). The systematic process of motivational design. *Performance and Instruction, 26*(9), 1-8.

Keller, J. M. (1996). Motivational design and multimedia: Beyond the novelty effect. *Proceedings of the International Symposium on New Technologies of Instruction, 12*

Keller, J. M. (1999). Using the ARCS motivational process in computer-based instruction and distance education. *New Directions for Teaching and Learning, 78*, 39-47.

Keller, J. M. (2006). What is motivational design? Retrieved from http://www.arcsmodel.com/pdf/Motivational%20Design%20Rev%20060620.pdf

Keller, J. M. (2008). First principles of motivation to learn and e[superscript 3]-learning. *Distance Education, 29*(2), 175. Retrieved from http://ezproxy.lib.ucf.edu/login?URL=http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ801002&site=ehost-live

Kerlinger, F. N. (1979). *Behavioral research: A conceptual approac*h. New York, NY: Holt, Rinehart, and Winston.

Kirkpatrick, D. (1996). Great ideas revisited: Revisiting kirkpatrick's four level model. *Training and Development, 5*0(1), 54-59.

Kirkpatrick, D. L. (1959a). Techniques for evaluating training programs. *Journal of ASTD, 1*3, 3-9.

Kirkpatrick, D. L. (1959b). Techniques for evaluating training programs: Part 2-learning. *Journal of ASTD, 1*3, 21-26.

Kirkpatrick, D. L. (1960a). Techniques for evaluating training programs: Part 3-behavior. *Journal of ASTD, 1*4, 13-18.

Kirkpatrick, D. L. (1960b). Techniques for evaluating training programs: Part 4-results. *Journal of ASTD, 1*4, 28-32.

Kirkpatrick, D. L. (1998). *Evaluating training programs: The four level*s. San Francisco, CA: Berrett-Koehler Publishers, Inc.

Kirkpatrick, D. L., & Kirkpatrick, J. D. (2005). *Transferring learning to behavio*r. San Francisco, CA: Berrett-Koehler Publishers, Inc.

Kozma, R. B. (1994). Will media influence learning? reframing the debate. *Educational Technology Research and Development, 4*2(2), 7-19.

Lakoff, G. (1987). *Women, fire and dangerous things: What categories reveal about the mind*. Chicago: University of Chicago Press.

Linden Labs. (2009). *1 billion hours, 1 billion dollars served: Second life celebrates major milestones for virtual worlds*. Retrieved February 8, 2010, from http://lindenlab.com/pressroom/releases/22_09_09

Low, R., & Jin, P. (2009). Motivation and multimedia learning. In R. Zheng (Ed.), *Cognitive effects of multimedia learning* (pp. 154-172). Hershey, NY: Information Science Reference.

Maslow, A. H. (1954). *Motivation and personality*. New York, NY: Harper & Row.

Maw, W. H., & Maw, E. W. (1968). Self-appraisal of curiosity. *Journal of Educational Research, 61*(10), 462-465.

Mayer, R. E. (1999). *The promise of educational psychology: Vol. 1, learning in the content areas*. Upper Saddle River, NJ: Prentice Hall.

Mayer, R. E. (2002). *The promise of educational psychology: Vol. 2, teaching for meaningful learning*. Upper Saddle River, NJ: Prentice Hall.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The cambridge handbook of multimedia learning* (pp. 31-48). Cambridge, NY: Cambridge University Press.

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

McClelland, D. C. (1965). Toward a theory of motive acquisition. *American Psychologist, 20*(5), 321-333.

McClelland, D. C., Atkinson, J. W., Clark, R. A., & Lowell, E. L. (1953). *The achievement motive*. New York, NY: Appleton-Century-Crofts.

McLoughlin, C., & Luca, J. (2001). Quality in online delivery: What does it mean for assessment in E-learning environments? Paper presented at the *ASCILITE 2001,* University of Melbourne, Au. 417-426.

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

Miller, G. A. (1994). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 10*1(2), 343-352.

Moore, M. G. (1997). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance educatio*n (pp. 22-38). New York, NY: Routledge.

Moskal, P. D., Dziuban, C., & Hartman, J. (2009). Online learning: A transforming environment for adults in higher education. In T. Kidd (Ed.), *Online education and adult learning: New frontiers for teaching practice*s (). Hershey: PA: IGI Global.

Muilenburg, L. Y., & Berge, Z. L. (2005). Student barriers to online learning: A factor analytic study. *Distance Education, 2*6(1), 29-48.

Mulaik, S. A. (1972). *The foundations of factor analysi*s. New York, NY: McGraw-Hill.

Newstrom, J. W. (1978). Catch-22: The problems of incomplete evaluation of training. *Training and Development Journal, 3*2(11), 22-24.

Nisbett, R. E., & Ross, L. (1980). *Human inference: Strategies and shortcomings of social judgmen*t. Englewood Cliffs, NJ: Prentice Hall.

Northrup, P. T. (2001). A framework for designing interactivity into web-based instruction. *Educational Technology, 4*1(2), 31-39.

Paas, F., Renkl, A., & Sweller, J. (2003a). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist, 3*8(1), 1-4. doi:10.1207/S15326985EP3801_1

Paas, F., Renkl, A., & Sweller, J. (2003b). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 3*2(1), 1-8. doi:10.1023/B:TRUC.0000021806.17516.d0

Paas, F., Tuovinen, J. E., Van Merrienboer, J. J. G., & Aubteen Darabi, A. (2005). A motivational perspective on the relation between mental effort and performance: Optimizing learner involvement in instruction. *Educational Technology Research and Development, 53*(3), 25-34.

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, Pascal 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 Merriendboer, J. J. G. (1994). Measurement of cognitive load in instructional research. *Perceptual & Motor Skills, 79*(1), 419-430. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=9501281531&site=ehost-live

Paivio, A. (1983). The empirical case for dual coding. In J. C. Yuille (Ed.), *Imagery, memory, and cognition: Essays in honor of allan paivio* (pp. 307-332). Hillsdale, NJ: Lawrence Erlbaum Associates.

Paivio, A. (1990). *Mental representations: A dual coding approach*. New York, NY: Oxford University Press.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach*. Hillsdale, NJ: Erlbaum.

Peterson, L., & Peterson, M. J. (1959). Short-term retention of individual verbal items. *Journal of Experimental Psychology, 58*(3), 193-198.

Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications*. Englewood Cliffs, New Jersey: Prentice Hall.

Prensky, M. (2002). The motivation of gameplay. *On the Horizon, 10*(1), 5-11.

Ramsden, P. (1992). *Learning to teach in higher education*. London: Routledge.

Reigeluth, C. M. (1979). In search of a better way to organize instruction: The elaboration theory. *Journal of Instructional Development, 2*(3), 8-15.

Reigeluth, C. M. (1999). The elaboration theory: Guidance for scope and sequence decisions. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory (volume II)* (pp. 425-453). Mahwah, NJ: Lawrence Erlbaum Associates.

Reigeluth, C. M., & Darwazeh, A. (1982). The elaboration theory's procedure for designing instruction. *Journal of Instructional Development, 5*(3), 22-32.

Rosenzweig, S., & Murray, H. A. (1938). *Explorations in personality*. New York, NY: Oxford University Press.

Rotter, J. B. (1954). *Social learning theory and clinical psychology*. New York, NY: Prentice-Hall.

Rowntree, D. (1992). *Exploring open and distance learning*. London: Routledge.

Rubio, S., Díaz, E., Martín, J., & Puente, J. M. (2004). Evaluation of subjective mental workload: A comparison of SWAT, NASA-TLX, and workload profile methods. *Applied Psychology: An International Review, 53*(1), 61-86. doi:10.1111/j.1464-0597.2004.00161.x

Saba, F., & Shearer, R. (1994). Verifying key theoretical concepts in a dynamic model of distance education. *American Journal of Distance Education, 8*(1), 36-59.

Salomon, G. (1983). The differential investment of mental effort in learning from different sources. *Educational Psychologist, 18*(1), 42-50.

Salomon, G. (1984). Television is 'easy' and print is 'tough': The differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology, 76*(4), 647-658. doi:10.1037/0022-0663.76.4.647

Schankman, L. (2004). Holistic evaluation of an academic online program. Paper presented at the *20th Annual Conference on Distance Teaching and Learning,* Madison, WI. 13-29.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. detection, search, and attention. *Psychological Review, 84*(1), 1-66. doi:10.1037/0033-295X.84.1.1

Schunk, D. H., Ames, C., & Ames, R. (1989). *Research on motivation in education. vol. 3: Goals and cognitions*. San Diego, CA: Academic Press.

Seligman, M. E. P. (1975). *Helplessness*. San Francisco, CA: Freeman.

Shea, P., Fredericksen, E., Pickett, A., & Pelz, W. (2004). Faculty development, student satisfaction, and reported learning in the SUNY learning network. In T. Duffy, & J. Kirkley (Eds.), *Learner-centered theory and practice in distance education* (pp. 343-377). Mahway, NJ: Lawrence Elrbaum Associates.

Shea, P., McCall, S., & Ozdogru, A. (2006). Adoption of the multimedia educational resource for learning and online teaching (MERLOT) among higher education faculty: Evidence from the state university of new york learning network. *MERLOT Journal of Online Learning and Teaching, 2*(3)

Sims, R., & Jones, D. (2003). Where practice informs theory: Reshaping instructional design for academic communities of practice in online teaching and learning. *Information Technology, Education and Society, 4*(1), 3-20.

Sitzmann, T., Kraiger, K., Stewart, D., & Wisher, R. (2006). The comparative effectiveness of web-based and classroom instruction: A meta-analysis. *Personnel Psychology, 59*(3), 623-665.

Sloman, S. A. (2002). Two systems of reasoning. In T. Gilovich, D. Griffin & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 379-396). New York, NY: Cambridge University Press.

Song, L., Singleton, E. S., Hill, J. R., & Koh, M. H. (2004). Improving online learning: Student perceptions of useful and challenging characteristics. *The Internet and Higher Education, 7*(1), 59-70.

Song, S. H., & Keller, J. M. (2001). Effectiveness of motivationally adaptive computer-assisted instruction on the dynamic aspects of motivation. *Educational Technology Research and Development, 49*(2), 5-22.

Sorrentino, R. M., & Higgins, E. T. (1986). Motivation and cognition: Warming up to synergism. In T. Higgins, & R. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 3-19). New York, NY: Guildford Press.

Steele-Johnson, D., Beauregard, R. S., Hoover, P. B., & Schmidt, A. M. (2000). Goal orientation and task demand effects on motivation, affect, and performance. *Journal of Applied Psychology, 85*(5), 724-738.

Summers, J. J., Waigandt, A., & Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education, 29*(3), 233-250.

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-learning? an empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*(4), 1183-1202.

Suzuki, K., & Keller, J. (2006). Proposing a layer model for e-learning design. Paper presented at the *A Paper Presented at 22nd National Conference of Japan Society for Educational Technology,* Kansai University, JAPAN.

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

Sweller, J., Van Merrienboer, J. J. G., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-296.

Thurmond, V. A., Wambach, K., Connors, H. R., & Frey, B. B. (2002). Evaluation of student satisfaction: Determining the impact of a web-based environment by controlling for student characteristics. *The American Journal of Distance Education, 16*(3), 169-190.

Travers, R. M. W. (1977). *Essentials of learning* (4th ed.). New York, NY: Macmillan.

Tuckman, B. W. (2003). The effect of learning and motivation strategies training on college students' achievement. *Journal of College Student Development, 44*(3), 430-437.

Turner, J. C., & Meyer, D. K. (2000). Studying and understanding the instructional contexts of classrooms: Using our past to forge our future. *Educational Psychologist, 35*(2), 69-85.

van Merriënboer, Jeroen J. G., Kirschner, P. A., & Kester, L. (2003). Taking the load off a learner's mind: Instructional design for complex learning. *Educational Psychologist, 38*(1), 5-13. doi:10.1207/S15326985EP3801_2

Visser, L., Plomp, T., & Kuiper, W. (1999). Development research applied to improve motivation in distance education. Paper presented at the *Selected Research and Development Papers Presented at the 21st National Convention of the Association for Educational Communications and Technology [AECT],* Houston, TX. 403-411.

Volet, S. (2007a). Emerging trends in recent research on motivation in learning contexts. In S. Volet, & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical and methodological implications* (1st ed., pp. 319-334). Kidlington, Oxford: UK: Pergamon.

Volet, S. (2007b). Understanding learning and motivation in context: A multi-dimensional and multi-level cognitive–situative perspective. In S. Volet, & S. Järvelä (Eds.), *Motivation in learning contexts: Theoretical and methodological implications* (1st ed., pp. 57-84). Kidlington, Oxford: UK: Pergamon.

Waugh, N. C., & Norman, D. A. (1965). Primary memory. *Psychological Review, 72*(2), 89-104.

Webb, N. M., & Shavelson, R. J. (2005). Generalizability theory: Overview. In B. S. Everitt, & D. C. Howell (Eds.), *Encyclopedia of statistics in behavioral science* (pp. 717-719). Chichester, NH: John Wiley & Sons, Ltd.

Weiner, B. (1974). *Achievement motivation and attribution theory*. Morristown, N.J.: General Learning Press.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71*(1), 3-25. doi:10.1037/0022-0663.71.1.3

Wittrock, M. C. (1989). Generative processes of comprehension. *Educational Psychologist, 24*, 345-376.

Woolfolk, A. E. (1993). *Educational psychology* (5th ed.). Needham Heights, MA: Allyn & Bacon.

Yang, Y., & Cornelious, L. F. (2005). Preparing instructors for quality online instruction. *Online Journal of Distance Learning Administration, 8*(1), 1-16.

Young, A., & Norgard, C. (2006). Assessing the quality of online courses from the students' perspective. *The Internet and Higher Education, 9*(2), 107-115.

Zheng, R. (Ed.). (2009). *Cognitive effects of multimedia learning*. Hershey, PA: Information Science Reference.