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THE EFFECT OF DIFFERENT PRESENTATION FORMATS OF HYPERTEXT  
ANNOTATIONS ON COGNITIVE LOAD, LEARNING AND LEARNER CONTROL

by

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A dissertation submitted in partial fulfillment of the requirements  
for the degree of Doctor of Philosophy  
in the Department of Educational Research, Technology and Leadership  
in the College of Education  
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## ABSTRACT

This dissertation study was intended to verify whether the positive effects of the roll-over annotation presentation format on reducing cognitive load and enhancing vocabulary and comprehension of 5<sup>th</sup>-grade children (Morrison, 2004) can be extended to college students' learning from a web-delivered text. In order to answer this research question, relevant constructs, such as cognitive load, learner control and learning, have been examined in this experimental study of 149 undergraduate students in a state university at College of Education.

No single effect of annotation presentation format on cognitive load was found, but an interaction effect on cognitive load was revealed between annotation presentation formats and pre-existing knowledge in this study of online education, similar to the interaction effect between annotation presentation formats and learners' reading experience found in traditional textbook learning (Yeung, Jin and Sweller, 1998; Yeung, 1999). Besides, students' computer experience also had a significant impact on their perceived cognitive load. One more key finding from this study was that the embedded annotation presentation format generated the least learner control, significantly different from other annotation presentation formats.

In conclusion, an adaptive approach to the design of annotation presentation formats is recommended, for example, individual differences including learners' familiarity with content should be considered along with different annotation presentation formats so as to reduce learners' overall cognitive load. Additionally, learners' computer experience should be examined when hypertext annotations are used. Finally, choices of annotation presentation formats should be well-conceived to balance cognitive load, learning, and learner control.

I dedicate this dissertation to my parents in China. Without their patience, understanding, encouragement, and most of all love, the completion of this work would not have been possible.

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## CHAPTER ONE: INTRODUCTION

### Background of the Study

Online education (interchangeably used with web-based, hypertext-based, or web-delivered learning/instruction in this study) is entering the mainstream of higher education in the United States. According to a comprehensive nationwide survey of all active United States postsecondary degree granting institutions accessible to the public, the growth rate for online enrollment continues to increase, from approximately 1.9 million students studying online in the fall of 2003 to over 2.6 million in the fall of 2004 (Allen & Seaman, 2004).

Among others, one obvious advantage of online education is attributed to its flexibility and potential cost savings. The Web allows students to choose which information they would like to access and when they would like to access it (Becker & Dwyer, 1994; Scheines, Leinhardt, Smith & Cho, 2005). Moreover, Arant, Coleman, & Daniel (2002) noted that studies have shown no difference in students' motivation regarding online courses and face-to-face classes. Online learning outcomes were claimed by most institutes to be equivalent or superior to face-to-face instruction (Moore, 2004; Scheines, Leinhardt, Smith & Cho) and the overall effectiveness of web-based learning has been positive (Don Sushikar, 2001; Derouza & Fleming, Maki & Maki, & Maki et al. as cited in Scheines Leinhardt, Smith & Cho).

Effective practices of online education in higher education consist of using instructional strategies that support learning objectives in the design, development and delivery of online course content. Content unfamiliar to individuals will be learned poorly unless scaffolding is provided during the learning process (Clark & Bean, as cited in Lee & Calandra, 2004). Given that web-delivered text is a major component of online course content, students' learning from

web-delivered text is considered essential, which can sometimes be fostered by providing scaffolding devices in online learning environment (Lee & Calandra).

Scaffolding refers to how learners' efforts can be supported while working in a learning environment (Lee & Calandra, 2004). For example, key concepts or new terms in a web-delivered text can be annotated with supplemental information that provides related explanations or contexts to guide a learner in information processing. In web-delivered texts, annotations can be designed and provided in the form of text, pictures, video clips, audio recordings or a combination of the different formats.

When used with textual information as a supplement in online learning environment, annotation can aid instructors in their efforts to help students understand related content (Plass, Chun, Mayer & Leutner, 2003) but they can also distract students. Cognitive overload (Lee & Calandra, 2004) refers to such an overwhelming demand on working memory resources for processing information at a specific moment (Cooper, 1998, Cognitive Load Theory, para.1; Sweller, 1988). In other words, the total amount of mental activity or effort via working memory is not meeting the required capacity for certain information processing.

The major factor that contributes to cognitive load is the number of elements that need to be attended. (Chandler & Sweller, 1996; Paas, Renkl and Sweller, 2003; Sweller, 1988; van Merriënboer & Ayres 2005). When annotations are provided and used as a type of supplementary course content in a web-delivered text, the additional cognitive demand induced by the annotations can exceed the individual's working memory capacity and as a consequence, the individual might be cognitively overloaded. Moreover, annotations can be designed and provided using various media modes (Asim & Ercetin, 2005) and presentation formats (Morrison, 2004) in online learning environments or multi-media systems. Therefore, the

cognitive load effect of annotations has become a productive research topic and a practical challenge for instructional designers in web-delivered or other multi-media learning environments.

### Statement of the Problem

In the last decade, a number of studies have examined functions and effects of annotations on recall, vocabulary learning, listening comprehension, text comprehension and problem solving in web-delivered education and other electronic learning environments. Text content in previous studies covered different disciplines ranging from second languages, foreign languages, literacy, history, social studies, to math, science, and technical education, using either expository, descriptive, or narrative text structures (Chun & Plass, 1996; Jones & Plass, 2002; Lee & Calandra, 2004; Plass, Chun, Mayer & Leutner, 1998; 2003; Wallen, Plass and Brunken, 2005). Functions, effects and effectiveness of annotations have been examined, in terms of the use of different or multiple media modes, such as verbal, visual or a combination of verbal and visual modes. Influences of individual differences have also been analyzed, including learning styles, learning preferences, prior knowledge level, verbal ability, and spatial ability. However, results of prior research related to functions, effects and effectiveness of annotations are inconclusive: no consistent relationship between the use of annotations and learning outcomes has been found in multi-media or online learning.

With online learning and a variety of multi-media strategies entering the mainstream of higher education, different annotation presentation formats are now being used. They may appear in multi-media or online courses as embedded annotations (Lee & Calandra, 2004), online

glossary annotations (Morrison, 2004), or roll-over annotations (Morrison). Embedded annotations refer to additional verbal explanations embedded in the original text. Learners do not need to use a mouse action to retrieve the supplemental information in a multimedia or online learning situation. Online glossary and roll-over annotations however, are additional information accessible to learners only with a mouse action. An online glossary appears as a pop-up window adjacent to the original text window and contains a listing of definitions or explanations for key concepts or terms in the original text. On the other hand, roll-over annotations are hidden explanatory notes, which pops-up when the mouse is moved or rolled over to touch each original concept or term.

One recent research (Morrison, 2004) has compared effects of different annotation presentation formats (embedded, online glossary, and roll-over) on vocabulary learning & reading comprehension of 5<sup>th</sup> grade children in online learning environments. It was claimed that the roll-over format was most effective and it facilitated vocabulary acquisition and text comprehension. Furthermore, it was implied that the roll-over annotation format reduced students' cognitive load.

Morrison's study (2004) with younger students raised the question if similar results would be achieved by college-level students. Both survey research and experimental research have been conducted to compare younger children and college students in a variety of learning situations. For example, significant differences were found between college students and younger children in many areas, including recreational reading, representations and reasoning in math problem-solving, computer anxiety, computer experience, text structure knowledge, recall, and learning from text (Glass, 2004; Kintsch, 1986; Todman & Lawrenson, 1992).



As cited in Yeung (1999), previous studies have also provided evidence of age-related differences in working memory (Salthouse, Salthouse, Fristoe, Lineweaver, & Coon), and in cognitive styles and strategies (Ashby, Tein, & Balakrishnan; Bjorklund & Harnishfeger; Cooney & Troyer; Martinetti; Rabinowitz & Wooley). Yeung's research itself indicated that there was a difference in reading comprehension and vocabulary acquisition tasks between elementary learners (younger or less experienced readers) and university readers (older or more advanced readers), using the same presentation format of vocabulary definitions.

On the other hand, learner control in terms of choices of content, path and pace (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988) was found to be related to cognitive load and learning (Morrison, 2004; van Merriënboer, Schuurman, de Croock, & Paas, 2002). van Merriënboer, Schuurman, de Croock, & Paas suggested that choices of problem formats enhanced performance due to the increased germane cognitive load. On the other hand, Morrison claimed that the roll-over presentation format of definitions reduced extraneous cognitive load and facilitated reading comprehension. Nevertheless, the effect of learning with different roll-over annotation presentation formats on college students' perceived control has not been further studied.

To summarize, the results from existing research related to annotations and specifically annotation presentation formats in online learning are inconclusive. Second, the online content using annotations can be extended to include other subject areas, such as educational psychology. Third, only a few researchers have examined the construct of learner control as related to cognitive load theory (Morrison, 2004; van Merriënboer, Schuurman, de Croock, & Paas, 2002). Finally, no research has been located that explored the effect of different presentation format of hypertext annotations on college students' perceived learned control.

In this dissertation, I address the first and second issues by designing an experiment that provided annotations in an educational psychology text to see if annotations can be effective in the content area of educational psychology. Then, I address the third and the last issue by exploring learner control effect generated by annotation presentation formats, in the hope of increasing our understanding of annotations provided in college-level online learning.

### Rationale and Purpose of the Study

Due to the age-related differences in working memory (Salthouse, Salthouse, Fristoe, Lineweaver, & Coon as cited in Yueng, 1999), recall, and learning from texts (Glass, 2004; Kintsch, 1986; Todman & Lawrenson, 1992), it is researchable whether different annotation presentation formats impact college students' perceived cognitive load, learner control and learning differently. The first focus of this study was to extend Morrison's (2004) study to examine the effects of different annotation presentation formats on college students' cognitive load in online learning environments. The content of the web-delivered text was drawn from two educational psychology textbooks (Eggen & Kauchak, 2004; Woolfolk, 2004). Eight annotations were provided in the web-delivered text, using different online presentation formats. One central purpose of this study was to see whether Morrison's findings and conclusions about the positive effectiveness of the roll-over annotation presentation format due to its reduced extraneous cognitive load can be extended from younger 5<sup>th</sup> grade children to college students.

On the other hand, according to Morrison (2004), learner control generated from the roll-over presentation format enhanced learning. However, learner control in Morrison's study was not explicitly defined and examined. Therefore, a second focus of the present study was to

explore the effect of learner control (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988) generated by different hypertext annotation presentation formats. Based on a review of literature related to learner control with respect to the choice of content, path, and pace (Chou & Liu; Hsiao; Kinzie, Sullivan, & Berdel), it is operationally defined in this study as the degree to which learners feel they have control over accessing or using annotations. Specifically, learners are required to choose the degree of agreement (from “strongly agree” to “strongly disagree”) concerning their control or choices over what annotations to access, how to access annotations, and when to access annotations.

Learning from text is not to be equated with remembering the text (Kintsch, 1986; Hamilton, 2004; Wallen, 2002). Comprehension is of greater importance to learning in a content area (Hamilton, 2004; Wallen, Plass and Brunken, 2005). Current research on text comprehension has provided guidelines for not overloading working memory (Plass, Chun, Mayer & Leutner, 2003; Wallen, Plass and Brunken). Therefore, a third focus of the present study is to examine college students’ learning in two levels: 1) whether annotations will help students remember the content (or knowledge); and 2) whether annotations will enhance students’ comprehension of the subject matter related to educational psychology.

### Significance of the Study

Prior research examined the cognitive load effect of instructional methods on learning in a wide array of subject areas, such as math (Paas & Van Merriënboer, 1994; Sweller, 1988), statistics (Paas, 1992), science (Chandler & Sweller, 1991), technical areas (Chandler & Sweller, 1996; Sweller, Chandler, Tierney & Cooper, 1990), foreign languages (Plass, Chun, Mayer &

Leutner, 1998; 2003) & social studies (Lee & Calandra, 2004). Initially, cognitive load effect research was focused on the complex learning in technical area and problem solving in math and science. Recently, researchers started to examine cognitive load effect in languages, social studies and other arts areas. The web-delivered text of this study was drawn from educational psychology textbooks and involved students in the learning of human development theory, therefore, the result of this study may contribute to the growing body of research related to cognitive load theory by including learning from the educational psychology text.

### *Theoretical Significance*

Research on learner control (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988) generated by different annotation presentation formats have not been conducted yet. The current research explored and compared learner control effect of different annotation presentation formats. Therefore, this dissertation has the potential of increasing our knowledge about learner control generated by different annotation presentation formats. Furthermore, the current study examined the relationship of learner control and cognitive load generated by different annotation presentation formats. There were preliminary indications of learner control as related to cognitive load in prior research (Morrison, 2004; van Merriënboer, Schuurman, de Croock, & Paas, 2002). The learner control dimension of annotation presentation formats in online learning, if confirmed in this study, will expand the conceptual framework and theoretical foundation of cognitive load theory used for the design of hypertext-based instruction (Gerjets, & Scheiter, 2003).

### *Practical Significance*

In practice, the result of the current study can inform instructional designers of effective annotation presentation formats in the design of multimedia learning system or online courses for

college of education students, in terms of learner control, cognitive load and learning respectively. First, this study will confirm if the implications of the cognitive load effect of different annotation presentation formats (Morrison, 2004) and the effectiveness of the roll-over presentation format can be extended from the 5<sup>th</sup> grade students to college students, when the design of online educational psychology courses are planned. Second, the learner control effect of different annotation presentation formats examined in this study has the potential to contribute to the practice of hypertext-instruction. Finally, the relationship between the two important constructs of learner control and cognitive load will inform the design of online learning.

## CHAPTER TWO: LITERATURE REVIEW

In this chapter, I will review literature of Cognitive Load Theory (CLT), hypertext annotations research including the effects of annotations on reading, and motivational theories related to learner control in order to situate my study of annotation presentation formats in various contexts such as CLT, learner control, and reading research. In my review related to CLT, I discuss CLT assumptions, definition of cognitive load, categories of cognitive load, effects generated by CLT, and measurement of cognitive load. Next, I review hypertext annotations, focusing on its definition, classifications, functions, effects, and particularly, the use of annotations in reading. Finally, because learner control is emphasized by various motivational theories, I review motivation literature in general related to learner control and then specifically discuss learner control in view of CLT to better contextualize my study of annotation presentation formats.

### Cognitive Load Theory

Originated in the 1980s, CLT (Sweller, 1988; 1989) has undergone substantial development and expansion (Chandler & Sweller, 1991; 1996; Kalyuga, Chandler & Sweller, 1999; 2003; Paas, 1992; Paas & van Merriënboer, 1994; Plass, Chun, Mayer, & Leutner, 1998; 2003), establishing itself as a major theory in the field of learning and instruction. By relating cognitive processes to instructional design, CLT has provided practical guidelines and frameworks for the design of multimedia systems and online learning (Morrison, 2004; Morrison & Anglin, 2005; Paas, Renkl, & Sweller, 2003; van Merriënboer & Ayres, 2005).

Based on human cognitive architecture, CLT mainly depicts the structure of information and their cognitive load consequences. Human cognitive architecture consists of a working memory and a long-term memory (Sweller, 1988). “The structure we use to initially hold information presented to us is called working memory. (Until fairly recently, it was called short-term memory.) The easiest way to think of working memory is in terms of consciousness.” (Sweller, 1999, p.4) Working memory refers to the immediate consciousness or cognitive resources used to process information drawn either from our environment, our long-term memory or a combination of our environment and long-term memory (Sweller). Working memory is very limited in duration and capacity (Miller; Peterson & Peterson as cited in Chandler & Sweller, 1996; Schunk, 2000; Sweller, 1998). On the other hand, long-term memory holds very large amounts of information for indefinitely long periods of time in the form of schemas (Bartlett; Gick & Holyoak; Thorndyke & Hayes-Roth as cited in Chandler & Sweller), or “categorical knowledge” (Anderson, 2000, p.155) that represent the structure of objects, concepts, persons, and events. In other words, schemas are the fundamental building blocks of knowledge.

Although stored in long-term memory, schemas are constructed in working memory: relevant information is processed in working memory before being stored in schematic form in long-term memory. Each schema varies in size and degree of complexity and acts as a single element when it is extracted and manipulated in working memory. In a sense, schemas are “designed to circumvent our limited working memories and emphasize our highly effective long-term memories” (Chandler & Sweller, 1996, p.1). Therefore, the prime goals of instruction are the construction and automation of schemas. (Sweller, 1999)

### *Assumptions of CLT*

Based on human cognitive architecture, CLT focuses on the role of working memory in schema construction and automation. According to Cooper (1998), the fundamental principles of CLT are based on the following four arguments:

1. Working memory is extremely limited.
2. Long term memory is essentially unlimited.
3. The process of effective learning requires working memory to be actively engaged in the processing of instructional content, and to encode new information into long term memory as new schema.
4. For effective learning to occur, the demand of the learning content or activities can not exceed available working memory resources (Para. 5).

### *Definition of Cognitive Load*

Cognitive load can be defined by the total amount of mental activity (Cooper, 1998) at a specific moment. The major factor that contributes to cognitive load is the number of elements of the new information that need to be attended to, which can be used as a simple representation of cognitive load.

For example, following are two statements (Statement 1 and Statement 2) and their respective cognitive loads.

Statement 1: I like dogs.                                      has 3 cognitive loads

Statement 2: Dogs are smart and sweet.                has 6 cognitive loads





memory load that interferes with rather than aids in schema acquisition and construction, or the very learning process intended by the instructional procedure (Sweller).

The learning process consists of revolving stages of constructing and automating schema via working and long-term memory. Difficulty in understanding new content is related to an interaction between the elements of the new content and previously acquired schemas. If the relationship between the new elements and previously acquired schemas is simple or the elements of the new content can be acquired independently from each other, then there is low “element interactivity” (Sweller, 1999, p.25) and the demand on working memory is low.

A heavy working memory or cognitive load occurs in novice learners when the relationship between the new elements and previously acquired schemas is complex, or the new elements need to be learned simultaneously. For learners with expertise or those who hold automated or higher level schemas in their long term memory, their previously acquired schemas can incorporate the complex elements of the new content and reduce the working memory or cognitive load of the new content. (Cooper, 1998; Sweller, van Merriënboer & Paas, 1998; Yeung, Jin, & Sweller, 1998; Yeung, 1999)

### *Categories of Cognitive Load*

For a particular learner in a particular learning condition, three types of cognitive loads may be imposed on their working memory: intrinsic, extraneous, and germane load. The total cognitive load induced from learning the new content cannot exceed the capacity of the working memory if effective learning is to occur. (Paas, Renkl and Sweller, 2003; Sweller, 1988; Sweller, van Merriënboer & Pass, 1998)

Intrinsic load is the base load, which is imposed by the content to be learned, usually depending on its complexity. In contrast, extraneous load is the load on working memory induced by unnecessary instructional designs or presentations. Extraneous load is also known as the ineffective cognitive load. As opposed to extraneous load, germane load is the effective load on working memory, referring to the demand on working memory when necessary and relevant instructional designs or presentations are used. (Chandler & Sweller, 1996; Paas, Renkl and Sweller, 2003; Sweller, 1988)

### *Intrinsic Load*

The intrinsic load is determined not just by the complexity of the content to be learned, but also by the characteristics of the learner. For example, the symbols of chemical elements such as “Fe” for iron & “Cu” for copper can be learned in isolation, or independently of the symbols of any other chemical elements, thus inducing low intrinsic demands on the learner. However, if the learner does not have a prior knowledge of each of the individual letter, such as “F”, “e”, “C” & “u”, high intrinsic demands are presented because the learner has to learn the letters and their combinations for the chemical symbols simultaneously. In contrast, when a learner has expertise on the letters, they can incorporate the interacting elements (the letters and their combination for certain chemical symbols) into one schema, which act as one element (“Fe”, as a chemical symbol for iron) in the working memory, thus reducing the intrinsic load (Sweller, 1988) of the symbol for the learner with expertise on letter.

### *Extraneous Load*

Extraneous cognitive load is likely to occur when working memory resources must be used for irrelevant activities, for example, when learners come across an unclear explanation. Learning content that has redundant information is a common source of extraneous load, or the

so-called redundancy effect. Presentation of physically separated multiple sources of information is another common source of extraneous load, or the so-called split-attention effect, which requires mental integration of multiple sources. Extraneous load in this case can be minimized by physically integrating multiple sources of information. (Chandler & Sweller, 1996; Paas, Renkl and Sweller, 2003; Sweller, 1988)

According to van Merriënboer & Ayres (2005), extraneous load can also be reduced by presenting a text in a spoken form and a diagram in a written form when both sources of the information are needed for simultaneous processing of the text and the diagram. Thus, the load can be distributed between the partially independent visual and auditory sub-processors of the working memory, or the so-called modality effect.

#### *Germane Load*

The last category of cognitive load is germane or effective cognitive load on working memory when unused cognitive resources deducted from intrinsic load are not demanded by improper instructional design but devoted to schema acquisition and construction. In other words, while distracting instructional design or irrelevant learning activities cause extraneous or ineffective cognitive load and interfere with learning, relevant and engaging instructional design and learning activities increase germane or effective cognitive load and enhance learning. (Paas, Renkl and Sweller, 2003)

Germane cognitive load can be increased based on the manner in which a task is presented, the “salience of defining characteristics”, or the context in which a task is performed (Sweller, van Merriënboer & Pass, 1998, p.5). Specifically, “high contextual interference” (de Croock, van Merriënboer, and Paas, 1998, p. 10), a random practice schedule in which different

problems were sequenced in a random order, had positive effects on transfer of trouble-shooting skills. (van Merriënboer, Schuurman, De Croock & Paas, 2002)

To sum up, high cognitive loads may be caused both by the intrinsic nature of the material being learned and by the method of presentation. If the intrinsic cognitive load is low, the extraneous cognitive load caused by instructional designs may not be very important. In contrast, extraneous cognitive load is critical when dealing with intrinsically high element interactivity materials. In other words, when the intrinsic load of material to be learned is relatively low for a specific learner, or when the extraneous load plus intrinsic load is not surpassing the total working memory of a particular learner, learning still occurs (Morrison, 2004). Nevertheless, extraneous load or ineffective load should be always be minimized so that learning can be optimized for all learners in all learning conditions.

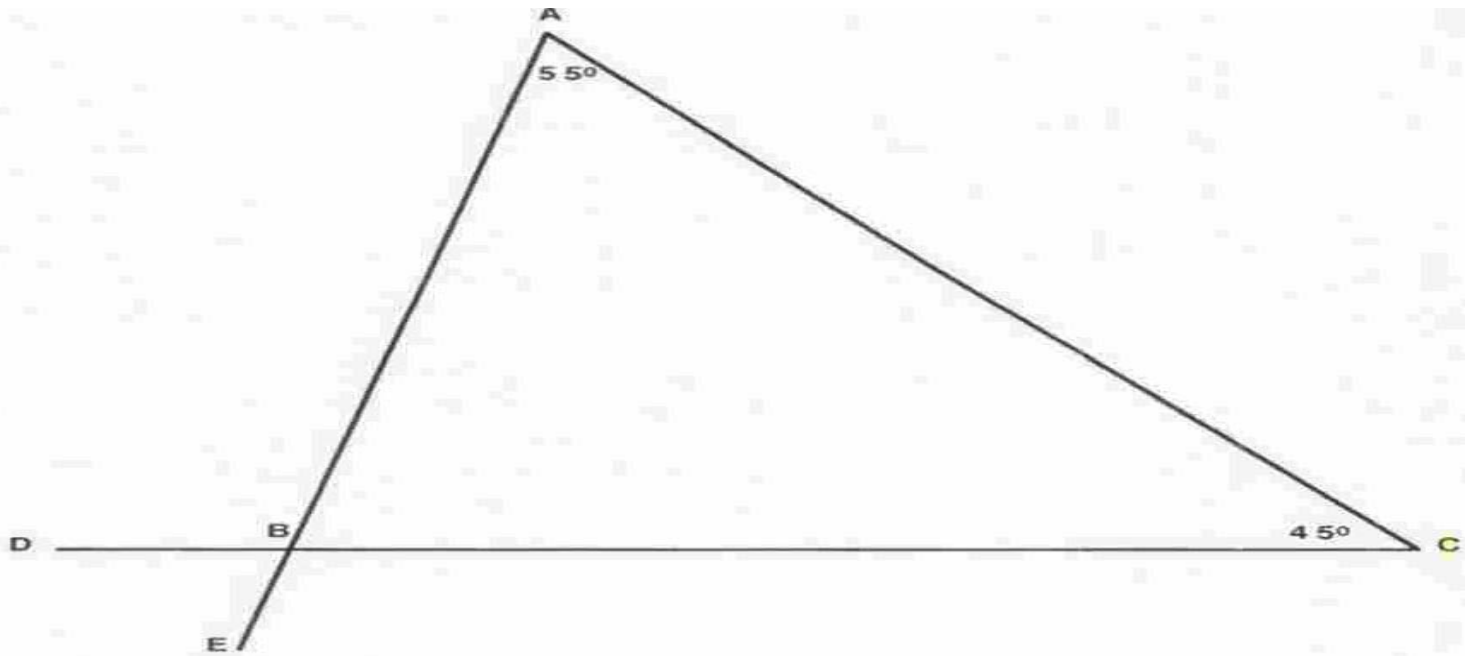
#### *Some Effects Generated by Cognitive Load Theory*

Cognitive load theory has been used to develop several instructional techniques, which have been well-tested in a variety of learning situations. The cognitive load effects related to these techniques include the split attention effect, the modality effect, and the redundancy effect, just to name a few. Each of the effects when appropriated used could provide benefits to learners, including reduced training time, enhanced performance (both shorter times to complete problems & fewer errors), and enhanced transfer of learning.

### *Split Attention Effect*

The split attention effect occurs in learning situations where multiple sources of information are presented separately that need to be mentally integrated to be understood. By replacing multiple sources of information with a single, integrated source of information, the split attention effect may be eliminated and learning may be facilitated. (Cooper, 1998)

A number of researchers (Chandler and Sweller; Mayer; Mayer and Gallini; Tarmizi and Sweller as cited in Yeung, 1999) have indicated that instructions using diagrams and text should be physically integrated if the diagrams and text need to be mentally integrated to be understood. As illustrated below in Figure 2, the simple formula was directly embedded into the diagram and signals were used to make the search process easier for learners than the separate format illustrated in Figure 1. Both Figure 1 and 2 are examples used by Sweller, van Merriënboer, & Paas (1998, see Figure 2: Example demonstrating split attention & Figure 3: Integrated example with no split attention.) and permissions were granted for reprint in this dissertation (see Appendix U).



In the above Figure, find a value for Angle DBE.

**Solution:**

$$\begin{aligned} \text{Angle } ABC &= 180^\circ - \text{Angle } BAC - \text{Angle } BCA \text{ (Internal angles of a triangle} \\ & \hspace{15em} \text{sum to } 180^\circ) \\ &= 180^\circ - 55^\circ - 45^\circ \\ &= 80^\circ \end{aligned}$$

$$\begin{aligned} \text{Angle } DBE &= \text{Angle } ABC \text{ (Vertically opposite angles are equal)} \\ &= 80^\circ \end{aligned}$$

Figure 1: An Example of Separated Format

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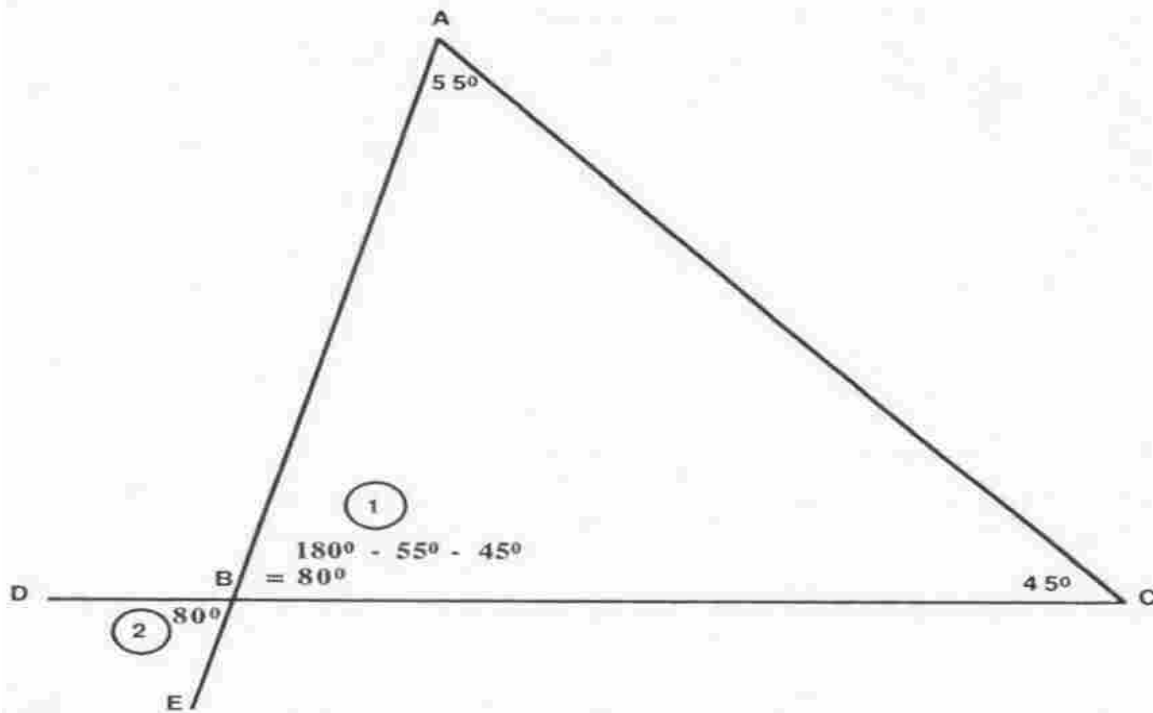


Figure 2: An Example of Integrated Format

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Also, Chandler and Sweller (1996) reported that the common practice in software training caused the split attention effect when learners needed to simultaneously refer to a hard copy tutorial (or manual) and the computer during the training. The manual-only-group completed their training on manual but performed better than the group who had both manual and computer for the software training. Later, Cerpa, Chandler & Sweller as cited in Cooper (1998) developed a computer based training package which integrates text-based instructions into a computer simulation of the target computer package. In doing so, the split attention effect was eliminated and learning was improved.

Evidence has been provided that reading conventional experimental papers resulted in the split attention effect as reviewed in Cooper (1998). The results section and the discussion



section of conventional papers were reported separately, but needed to be considered simultaneously due to the complexity of results and their implications. By integrating the results and the discussion section, the split attention effect may be prevented and reading may be improved.

To recapitulate, the integrated format technique to eliminate the split attention effect was found to be useful in mathematics and science instruction (Sweller & Chandler; Tarmizi & Sweller as cited in Yeung, 1999). Moreover, Yeung, Jin and Sweller (1998) found that physically integrating the text and definitions of target words may be useful in reading instruction.

### *Modality Effect*

Multimedia instructions can be more effective when the verbal/textual information in Figure 1 as depicted above is presented in an auditory instead of visual format, namely, the modality effect (Cooper, 1998; Sweller, van Merriënboer & Paas, 1998). The modality effect is another alternative technique to the integrated format technique (see Figure 2 illustrated above) that may as well reduce the extraneous cognitive load caused by the so-called split-attention effect of the multiple sources of information presented in Figure 1.

The implications of the modality effect are based on Baddeley's theory and empirical studies about working memory sub components, which consists of auditory working memory that deals with verbal material, and visual working memory for diagrammatic/pictorial information. Furthermore, effective working memory capacity can be increased by using both visual and auditory working memory rather than either sub processor alone. (Sweller, van Merriënboer & Paas, 1998)

A number of experiments have demonstrated that presenting some part of the information visually (e.g., graphics), and other parts of information (e.g., text) in a spoken format enhanced

learning (Kanda; Mousavi, Low and Sweller; Jeung; Tindall-Ford, Chandler and Sweller as cited in Kalyuga, Chandler, & Sweller, 1999). The modality effect on learning is well-established in terms of lower mental effort during instruction and higher test scores (Kalyuga, Chandler, & Sweller), less time on subsequent problem solving (Yeung, 1997), and improved scores on retention, transfer and matching tests (Brunken, Plass, & Leutner, 2003).

One recent study by Tabbers, Martens and van Merriënboer (2004), however, reported a reverse modality effect, claiming that replacing visual text with spoken text resulted in lower retention and transfer scores in real classroom settings. One hundred and eleven second-year students from the Department of Education at the University of Gent in Belgium participated in the study. The experiment was carried out in three sessions, each of which had between 35 and 40 students randomly assigned to different experimental conditions (e.g., the bi-modal/audio-visual group and the visual-only group) to learn a web-based lesson for about one hour and complete a retention test and a transfer test afterwards. The group using the bimodal instructions was not found more effective to those using the visual-only instructions in their retention and transfer tests.

The contradictory results from prior studies related to the modality effect may be explained by the difference between the pacing of the instructions. Prior studies confirming the modality effect used system-paced multimedia instruction, that is, the instructional content is delivered to learners in a limited time while in Tabbers, Martens and van Merriënboer's study (2004), the learners studied the web-based content at their own pace. The advantage of bimodal instructions in system-paced instruction lies in the fact that the picture (visual) and the text (audio) can be perceived simultaneously, resulting in a lower extraneous load than in visual-only

instructions where the learner has to relate text to picture in the limited time. In the learner-paced instructions, however, this advantage disappears because the learner with the visual-only instructions does not have time constraints in relating the text to the graphic. Instead, learners can deal with the text and the picture much more easily in the visual-only instructions than in the bi-modal instructions, because spoken texts in the bi-modal format are harder to skim through than the visual text in the visual-only format. In brief, learner-paced instruction could make visual-only instructions more effective than bimodal instructions, which reverses the modality effect generated from the system-paced multi-media instruction. (Tabbers, Martens and van Merriënboer)

### *Redundancy Effect*

The redundancy effect is another obstacle to schema acquisition, imposing an undue cognitive load on the learner's working memory. It occurs when the learner is required to process nonessential or redundant information. By simply removing the redundant information, extraneous cognitive load may be reduced and learning may be enhanced. (Cooper, 1998)

According to Le Bohec (2005), the redundancy effect proposed by CLT mainly involves the following three contexts. First, it can be associated with the coherence of the document. In this case, the information is not directly relevant to learning, which generates an increased cognitive load and thus an impaired performance.

Second, it can be defined as the uselessness of information in dual formats (Cooper, 1998) as illustrated by Figure 3. Permissions were granted for the reprint of the figure in this dissertation (see Appendix V).

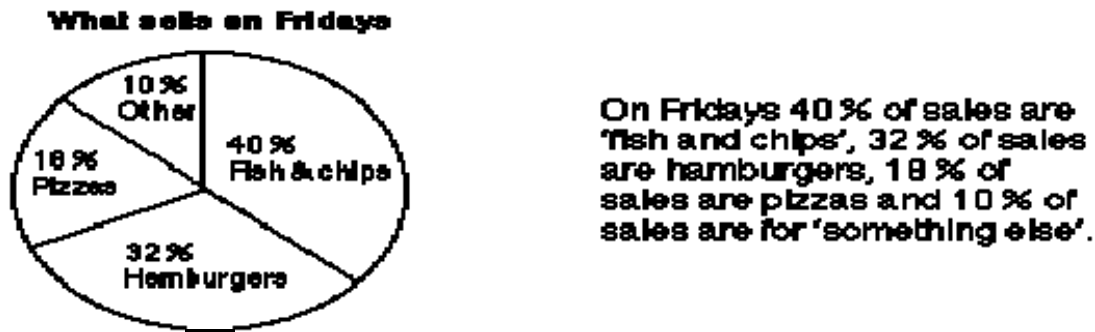


Figure 3: Redundant Information in Dual Formats

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Chandler and Sweller (1991) found that learning was enhanced by the elimination of textual material that described the contents of a diagram. More recently, Leahy, Chandler and Sweller (2003) demonstrated that a non-essential explanatory text, presented aurally with similar written text contained in a diagram, hindered learning. Because the aural material was unnecessary, it created a redundancy effect. When information was high in complexity, differences between the diagram-only group and the dual format group (audio & diagram) were stronger.

Finally, the redundancy effect can be linked to the level of expertise, given that the necessary or unnecessary nature of the piece of information depends on the level of expertise of the learner. Thus, a source of information might be essential for a beginner but redundant for someone who has more advanced knowledge in the field. For example, Darabi and Nelson's research (2004) showed that presenting new information to learners familiar with the content in a specific domain does not improve transfer and may induce extraneous cognitive load, due to the redundancy effect.

The goal of instructional design is to optimize cognitive load for a particular learner under a particular learning condition, which means using appropriate learning activities to reduce extraneous load and/or increase germane load, within the limits of the total cognitive load (Brunken, Plass, & Leutner, 2003; Sweller, 1998). Annotations could increase learners' extraneous load if the additional information is irrelevant or redundant (Lee & Calandra, 2004; Yeung, 1997; Yeung, Jin & Sweller, 1998; Yeung, 1999) or if the annotation presentation format is distracting for a specific learner (Kalyuga, Chandler, & Sweller, 1999; Morrison, 2004). An embedded annotation presentation format could cause extraneous load due to the so-called redundancy effect for experienced readers or readers with high expertise on the subject matter. On the other hand, a separate glossary might hinder learning due to the so-called split attention effect, i.e., students with low expertise or knowledge level need to search the explanatory notes in the glossary for some key concepts and hold them in their working memory while trying to understand the original key concepts with the help of the explanatory notes (Morrison; Yueng; Yeung, Jin & Sweller; Yeung).

To select between an embedded annotation presentation format and an online glossary has become a dilemma for instructional designers. Currently, the roll-over annotation presentation format has been widely used and thus become another choice of the multiple presentation formats in online learning environment. Furthermore, a combination of embedded annotations, online glossary annotations, and roll-over annotations is sometimes presented simultaneously in some web-based texts. One purpose of the current study is to investigate the different cognitive load effects of different annotation presentation formats provided in web-delivered instruction. In order to examine the cognitive load effects as generated by different

annotation presentation formats, we need to review the measurement of cognitive load, which is presented below.

### *Measure of Cognitive Load*

Cognitive load is generally considered a theoretical construct representing the load that performing a particular task imposes on the working memory. It can be classified either as a task-based dimension or as a learner-based dimension. Various methods of assessing cognitive load have been used in prior studies. (Brunken, Plass, & Leutner, 2003; Morrison & Anglin, 2005)

#### *Objective Measure*

The most common method of investigating cognitive load effects is to analyze performance outcomes because they are objective (Brunken, Plass, & Leutner, 2003). According to CLT, when learning content (with its specific intrinsic load) is presented in different ways to some randomly assigned groups, the observed different performance outcomes among the groups are caused by the presentation methods (with its specific extraneous load or germane load), rather than by the identical content (with identical intrinsic load). In other words, the higher performance score the specific instruction or presentation group acquires, the less extraneous load is induced by the presentation method, although the measurement of cognitive load is indirectly indicated by the performance scores.

Other indirect objective measurements of cognitive load analyze behavioral patterns or physiological conditions and functions. For example, how much time learners spend on some different instruction/presentation variations of a task can be seen as an indicator for different

cognitive load levels of the different task variations. When other variables are controlled, the less amounts of time it takes to learn a specific variation of the task, the less amounts of load the variation of the task induces. (Brunken, Plass, & Leutner, 2003)

### *Subjective Measure*

Subjective rating-scale techniques have also been used in prior cognitive load research. Subjects are asked to introspect on their cognitive processes and report the amount of mental effort expenditure or the difficulty of the learning situation, via assigning numerical values to their invested mental effort (Paas & van Merriënboer, 1994). Paas, Tuovinen, Tabbers, and van Gerven (2003) examined the frequent use of subjective measures of cognitive load in prior studies and claimed these subjective rating-scale techniques as valid, reliable and non-intrusive measures of cognitive load in the specific studies. For example, a 9-point symmetrical category scale measuring perceived mental effort had fair reliability, equaling 0.90 and 0.82 (Cronbach alpha) in the cognitive load studies conducted by Paas (1992) and Paas, van Merriënboer, and Adam (1994) respectively. Kalyuga, Chandler, and Sweller (1999), Morrison (2004), and Yeung (1999) used subjective measurement of cognitive load that directly rates the difficulty of the learning activities, which was reported to have a high sensitivity in identifying differences in training strategies.

Applying a confirmatory factor analysis approach to construct validation, Yeung, Lee, Pena, and Ryde (2000) developed a Subjective Mental Workload measure and claimed it to be a valid predictor of cognitive load. The Subjective Mental Workload Survey is based on four constructs, including difficulty, incompetence, affect and effort. According to Yeung, Lee, Pena, and Ryde, the subjective measure is applicable to analysis of group differences: groups scored higher when conducting tasks that overload working memory.

### *Dual-task measure*

One promising approach to measuring cognitive load directly and objectively is the use of the dual-task-analysis, which has been well-known in experimental psychology and working memory research. The dual-task analysis is based on the assumption that limited working memory can be allocated flexibly to different aspects of task solving. If a learner has to perform two tasks (e.g., one primary and one secondary task) simultaneously, the primary and the secondary task will accordingly take up and share the limited working memory. Furthermore, it is assumed that different variants of primary tasks require different amounts of cognitive resources. Thus, performance in processing a simultaneously presented secondary task varies according to the cognitive load induced by the primary task variants. (Brunken, Plass & Leutner, 2003)

Specifically, if two randomly assigned groups of subjects perform the same secondary task and simultaneously perform two different formats of the primary task, the time-on-task difference and or the performance error rate difference (measurements of the cognitive load of the formats of the primary task), if existing, is caused by the different formats of the same primary task. Following is an example of dual-task. Reading verbal and pictorial materials are presented as primary tasks while choosing correct or incorrect answers to simple equations (e.g.,  $3 + 3 = 6$ ;  $5 + 2 = 6$ ) are used as secondary tasks. If participants using one specific format of primary verbal and pictorial materials react to the secondary equation task in less amount of time, i.e., fewer intervals between task presentation and reaction, it is implied that this specific format of primary task presentation/instruction causes less cognitive load. Likewise, if fewer errors occur to learners during the processing of the secondary task while one specific format of



the primary reading task of verbal and pictorial materials is being simultaneously conducted, it can be argued that this specific format of primary task causes less cognitive load.

According to Brunken, Steinbacher, Plass, and Leutner (2002) and Brunken, Plass and Leutner (2003), the feasibility of the dual-task measurement has been validated in their experimental studies based on the modality effect generated by CLT. Using direct dual-task analysis of cognitive load, the audiovisual presentation of text-based and picture-based learning materials induced less cognitive load than the visual-only presentation of the same material, which confirmed the modality effect of CLT. Therefore, the direct and objective measurement of cognitive load using dual-task analysis has been recommended for assessing the difference of cognitive load when different modes of multi-media instructions are used. (Brunken, Plass and Leutner; Morrison & Anglin, 2005)

A combination of subjective rating scales with the objective performance outcome measures has been used in most cognitive load research, however. Following the trend of most cognitive load research, the current study adopts the objective measure of performance outcomes in addition to Yeung, Lee, Pena and Ryde's (2000) Subjective Mental Workload Survey as the assessment of cognitive load induced by different annotation presentation formats. However, to better understand different annotation presentation formats, an extensive review of annotations used in traditional and online learning is needed and therefore presented below.

### Hypertext Annotations

Hypertext annotations, sometimes used interchangeably with electronic glosses, hypermedia annotations, or multimedia annotations in the literature, refer to glossaries,

explanatory notes or supplemental information used in web-based or electronic learning environment. Generally speaking, hypertext annotations have similar features to those of glossaries or annotations provided in traditional texts.

However, hypertext annotations have some unique features due to the availability of multi-media modes, flexible connection methods via hyperlinks inherent in electronic or web-based learning, and various presentation formats in online learning. Also, most hypertext annotations are designed and provided by instructional designers, somewhat different from annotations generated by students while reading traditional texts, via underlining, circling, asking questions, making connections and generating elaborations (Moreland, Dansereau & Chmielewski, 1997).

### *Classifications of Hypertext Annotations*

Based on a review of literature related to the use of hypertext annotations, four major classifications of annotations can be made according to the focus of annotation content, the functions of annotations, the media modes used for annotations, and the presentation formats of annotations. The following are specific descriptions of annotations used in each of the four groups.

#### *Textual & Contextual Annotations*

According to the focus of the annotation content as the supplemental information, annotations can be categorized as textual annotations and contextual annotations. Textual, sometimes called verbal, annotations provide lexical or syntactic information at the word level. In contrast, contextual, or extra-textual annotations clarify important points or provide extra

information at the topic level (Ariew & Ercetin, 2004; Niederhauser, Reynolds, Salmen, & Skolmoski, 2000).

### *Functional and Non-functional Annotations*

Using a qualitative approach, Lee & Calandra (2004) proposed functional & non-functional annotations as an initial categorization of annotations used in a web-based text on a web site. Functional annotations refer to those that aid students in the construction of schema while nonfunctional annotations provide limited or no help or even distract students from learning.

Distinctions have been further made in terms of the levels of the functions of annotations, such as selection, organization and integration-level annotations (Hamilton; 2004; Wallen, 2002; Wallen, Plass & Brunken, 2005). The selection-level function of annotations (e.g., using word definitions) assists learners in their process of information selection. The organization-level function of annotations supports students in organizing information (e.g., using paraphrasing as connections between prior and new knowledge for the information being learned). Finally, the integration-level annotation plays a role in students' overall information integration (e.g., using summary as a method for students to integrate information).

Similarly, the non-functional annotations are further divided into simple non-functional, dependent non-functional and restrictive non-functional in Lee & Calandra's study (2004) related to the use of explanations for some content of the U.S. Constitution. Simple nonfunctional annotations are nonfunctional because they provide students with only a restatement of a well understood idea of the Constitution. Annotations offering partial explanation of some content that is completely unknown to students are classified as dependent annotations, functions of which are dependant on additional information or prior knowledge.

Finally, restrictive non-functional annotations are annotations that provide content unrelated to the topic to be learned and the additional content actually introduce a component relating to students' world perspective. The availability of such additional component positions students to make decisions between competing concepts based on their world perspective rather than the content of the original text.

#### *Visual, Audio, Verbal, and Multi-media Annotations*

Various media modes available in hypertext have resulted in the classifications of hypermedia annotations as visual (also known as graphics or picture annotations), video, verbal/textual, and audio annotations or audio-recordings (Asim & Ercetin, 2005; Plass, Chun, Mayer & Leutner 2003). One media mode or multiple media modes of annotations have been used depending on the material to be learned or the overall learning environment.

#### *Embedded, Online Glossary and Roll-over Annotations*

There are three very different verbal annotation presentation formats in web-based or multimedia learning environments: embedded (also known as in-text) annotation presentation format (Lee & Calandra, 2004, Morrison, 2004), online glossary (equivalent to hyperlink or adjunct) annotation presentation format (Morrison), and roll-over annotation presentation format (Morrison; Wallen, Plass & Brunken 2005). As stated in Chapter 1, embedded annotations refer to additional verbal explanations embedded in the original text. Learners do not need to use a mouse action to retrieve the supplemental information in a multimedia or online learning situation. Online glossary and roll-over annotations however are additional information accessible to learners only with a mouse action. An online glossary appears as a pop-up window adjacent to the original text window, which contains a listing of definitions and explanations for each highlighted concept or idea in the original text. On the other hand, roll-over annotations are

hidden explanatory notes, created by HTML and JavaScript computer programming languages, which appear adjacent to each original concept or idea only when the mouse or the icon is moved or rolled over to touch the highlighted concept or idea.

### *Functions and Effects of Hypertext Annotations*

The use of hypertext annotations has become very significant due to the thriving use of websites (e.g., blogs and wikis) as communication tools or learning resources. A blog (short for weblog) is basically a journal available on the web, intended for a community of users, and frequently updated by the author and other contributors to the blog. A wiki is a cooperative website which allows users to add and edit content collectively. It can also be a collection of websites of hypertext; each of them can be visited and edited by anyone. An increasing number of studies have been conducted related to the functions & effects of the use of annotations in hypertext (multi-media or web-based) learning environments in recent years. Following is a summary of previous studies related to the use of hypertext annotations.

### *Functions of Hypertext Annotations in Learning*

Results were generally consistent in the literature of functions of annotations, that is, annotations have sometimes been used as functional and sometimes as non-functional. One qualitative study utilized two versions of a website on the United States Constitution for students in high school history classes to explore the effects of embedded annotations vs. no annotations in web-based learning. It was discovered that the annotations sometimes functioned as a type of conceptual scaffold and helped students build unique schemas. Nevertheless, complex

annotations might cause students to respond with less correctness, but not necessarily with less depth or clarity. (Lee & Calandra, 2004)

Meanwhile, Wallen (2002) and Hamilton (2004) designed three different levels of functions of annotations using verbal or image forms for learning from a scientific text. Based on the generative theory of multimedia learning as cited in Wallen and Hamilton, selection-level annotations have been designed for selecting information, organization-level annotation for organizing information, and integration-level annotation for integrating information. For example, selection-level annotations are annotations that provide definitions of difficult words while organization-level annotations are annotations that provide connections for the information being learned. The integration-level annotations refer to summaries that are designed for students to integrate the overall material.

Results from Wallen's study (2002) and Hamilton's research (2004) have consistently shown that annotations used in hypertext can improve learning at many different levels of cognitive learning outcomes. Specifically, participants who viewed annotations at the selection and organization-level have done better on recall, comprehension and transfer tests than the control group that did not have access to such annotations. However, when multiple types of annotation functions have been provided, i.e., when a combination of either two or three of the selection-level, organization-level and integration-level annotations were used, learning outcomes were negatively affected, particularly for novice learners or those with lower verbal abilities.

#### *Effects of Hypertext Annotation Media Modes on Learning*

Results from prior studies have been in contrast with regard to effects of annotation media modes on learning. For example, Plass, Chun, Mayer, & Leutner (1998) and Jones & Plass

(2002) have stated that verbal and visual/picture annotations were effective and they enhanced comprehension in second language learning. In contrast, Arew and Ercetin (2004) and Asim and Ercetin (2005) have reported negative effects of multi-media annotations on reading comprehension.

Plass, Chun, Mayer, & Leutner (1998) and Jones & Plass (2002) conducted their studies in second language learning (including reading and listening) within real learning situations where participants were asked to learn from authentic materials. For key words in the story, students could choose to see verbal annotation or view a visual/picture annotation, or both. The content of the annotation were lexical or syntactic information at the word level. It was found that students recalled words and comprehended content more effectively when they had access to and actively selected visual and verbal modes of annotations than when they had access to or selected only one mode or neither. Moreover, when students had the opportunity to receive their preferred mode of annotation in second language learning, they remembered word translations and understood stories better in reading (Chun and Plass, 1996; Plass, Chun, Mayer & Leutner; Yeh and Wang, 2003).

In contrast, Asim and Ercetin (2005) and Arew and Ercetin (2004) reported negative effects of multi-media annotations on reading comprehension in second language learning. Different forms of media were used to provide annotations both at the word level and at the topic level. Specifically, the annotations included lexical or syntactic information at the word level and contextual or extra-textual annotations that clarify important points or provide extra information at the topic level. Results indicated that annotation use did not facilitate reading comprehension. Furthermore, a negative relationship was found between the time spent on video and graphics annotations and reading comprehension for the group of students with intermediate level of prior

knowledge. Audio-recordings, and videos were found to affect reading comprehension negatively (Asim & Ercetin; Ariew & Ercetin) although video/visual annotations were preferred significantly more than verbal and audio annotations (Ariew & Ercetin).

The discrepancy regarding effects of multi-media annotations on learning as revealed in the previous studies might be explained by cognitive load effects induced by the different multi-media modes of annotations and the content of annotations used in the studies. Plass, Chun, Mayer, & Leutner (1998) and Jones & Plass (2002) used a combination of verbal and picture modes, while Ariew and Ercetin (2004) and Asim and Ercetin (2005) used a combination of audio, visual/video, and verbal modes. In the latter studies, too many multi-media modes might have actually overloaded learners, causing the reverse modality effect. The different results of annotation use in learning can also be caused by the different focus of annotation content provided in the studies. Studies by Plass, Chun, Mayer, & Leutner and Jones & Plass only provided lexical or syntactic annotations to help students select information while Ariew and Ercetin and Asim and Ercetin provided both lexical information at the word level and contextual or extra-textual annotations at the topic level. Multifaceted functions of annotations used in the latter studies might have also caused overload on the average students (Lee & Calandra, 2004).

One central focus of the current study is to compare the effects of annotation presentation formats on knowledge recall and comprehension from reading a web-delivered text; therefore it is important to conduct a literature review on the use of annotations in reading research. In the following section, I will specifically discuss the effectiveness of annotations on vocabulary learning and comprehension in reading research.



## *Effectiveness of Annotations in Reading*

### *Annotations in Knowledge Recall*

Consulting annotations/gloss is one of the most common word-focused activities used during reading. The use of annotations/gloss can contribute to increase in Second Language vocabulary learning or knowledge recall (Chun and Plass; Lyman-Hager & Davis; Lyman-Hager et al.; & Watanabe as reviewed in Hill & Laufer, 2003; Jacobs; Davis; & Holley & King as cited in Jacobs, Dufon & Hong, 1994). For example, Knight (1994) found that learners of Spanish using an electronic dictionary/gloss recalled significantly more words in both immediate and delayed recall than learners who had no access to the electronic dictionary/gloss. Another piece of evidence of the positive effect of annotations/gloss on vocabulary learning or knowledge recall came from Jacobs, Dufon and Hong's study with eighty-five Spanish language program students at a large state university in the United States. Based on a vocabulary test administered shortly after reading, learners with glosses outperformed their peers who did not have glosses.

However, some researchers did not find any significant effects of annotations/gloss on knowledge recall or vocabulary learning (Johnson; & Pak, as cited in Jacobs, Dufon & Hong, 1994; Yeung, Jin & Sweller, 1998). For example, Yeung, Jin and Sweller conducted an experiment to examine whether explanatory notes at the lexical level, namely, textual annotations/explanatory notes, could have positive effects on vocabulary learning and knowledge recall. In their study, twenty-four English-speaking students (fifth grade, 10–11 years old) of a public primary school in metropolitan Sydney were randomly assigned to the explanatory notes condition and the no-explanatory notes condition. The textual annotations/explanatory notes were presented above appropriate sections of the text. When students completed reading in the

given time, they were required to write down the meaning of each of a list of 12 vocabulary items in the blank next to it. The comparison in vocabulary learning between the groups showed that the explanatory notes condition group did not outperform the no-explanatory notes condition group.

One possible explanation for the discrepancy in prior research is that other variables, such as those related to the additional information of the annotation/glosses and the difficulty of the text themselves, may cause different effects. For example, the provided glosses will be of no effect or even have a negative impact if they are redundant with the original information. Also, if a text is too far above learners' current level of knowledge, an appropriate amount of annotations/glossing may have the potential to result in an adequate degree of comprehension during reading, but not necessarily an increase in vocabulary/knowledge recall after reading. On the other hand, if a text contains no difficulties for students, glossing of certain words or concepts may become superfluous. This dissertation extends the existing research on the effectiveness of annotations/glosses in Second Language vocabulary learning to concept learning from an educational psychology text by examining whether different annotation presentation formats have significantly different impact on concept/knowledge recall.

#### *Annotations in Reading Comprehension*

Some prior research showed that annotations were effective in facilitating reading comprehension (Aweiss, 1993; Davis, 1989; Knight, 1994; Lomicka, 1998; Yeung, Jin & Sweller, 1998). For example, Aweiss claimed that glossary, when provided as a computer-mediated support, enhanced the comprehension of the beginning American readers of Arabic as a foreign language. In his study, twenty four first-year college students were given computer-assisted reading instruction at four levels of treatment: control (use of text only); access to a

glossary; access to conjugations of selected verbs in the text; and access to background information about the text. Results from the post-treatment reading comprehension scores suggested that of the three-computer-mediated reading supports used, the glossary was the primary contributor to comprehension enhancement. Another experimental study conducted by Davis found that providing definitions of words and comments as glosses no matter during or before reading, was more effective than providing no aids at all. Knight further investigated the effectiveness of annotations in reading comprehension by considering learners' verbal ability as another important variable. He randomly assigned 112 students of Spanish to electronic dictionary access and no electronic dictionary access conditions and found that both learners benefited from annotations. Moreover, using an electronic dictionary was more beneficial for low verbal ability students because the correlation between the frequency of word lookup and reading comprehension was much higher for this group than the high-verbal ability group (Knight).

On the other hand, some researchers did not find annotations to be effective in improving reading comprehension. For example, Davis and Lyman-Hager (1997) investigated how intermediate students of French interacted with a computerized second language reading gloss. Forty-two students read a glossed excerpt on the computer screen. After the reading, participants performed a recall protocol. Although students had an extremely positive reaction toward the software that provided gloss in English for the French text, no significant relationship was found between the use of gloss and reading comprehension. Furthermore, a negative correlation between annotation use and reading comprehension for intermediate learners was revealed in Ariew and Ercetin's (2004) study, while no relationship was observed between the two variables for the advanced group.

To sum up, prior studies have revealed insufficient and inconclusive results about whether annotations facilitate reading comprehension. In other words, there may not be a direct relationship between annotation use and reading comprehension (Ariew & Ercetin, 2004). Other variables, such as verbal ability and proficiency may interact with the effects of annotations. Annotations, for instance, may be more beneficial for low verbal ability and low proficiency learners (Knight, 1994). Furthermore, there was not much research exploring the relationship between annotation presentation formats and reading comprehension. The current study intends to extend the existing research on the effectiveness of annotations in reading comprehension by comparing the effectiveness of different annotation presentation formats in online reading comprehension.

#### *Effects of Annotation Presentation Formats on Reading*

Effects of verbal annotation presentation formats on knowledge and comprehension have been reported in both traditional and hyper texts. According to Yueng (1997; 1999) there was no effect of annotation presentation format *per se*. Neither the embedded format nor the separate glossary format should be considered more effective in improving vocabulary and comprehension, instead, the effect was found in the interaction between format and learners' reading expertise.

A series of experiments conducted by Yueng (1997; 1999) and Yeung, Jin, and Sweller (1998) on students with different reading expertise levels ranging from elementary to college levels indicated that annotation presentation formats such as in-text annotations and glossary annotations had different effects on recall and comprehension for younger children and older students. For less experienced readers, the integrated format reduced the split-attention effect for comprehension but induced redundancy effects for vocabulary learning. For more experienced

readers, the integrated format induced redundancy effects and hampered performance in comprehension. Specifically, with the less expert readers, the integrated format with vocabulary definitions embedded in text reduced the cognitive load related to search for meaning of new vocabularies and thus improved comprehension. Nevertheless, although comprehension was improved by an integrated format, vocabulary learning was hampered. For the less experienced readers, vocabulary was learned best when the vocabulary meanings were separated from the text.

In contrast, the more experienced readers did not require the vocabulary meanings to comprehend the text and thus their comprehension decreased in an integrated format. Although attending to vocabulary meanings in the integrated format reduced comprehension for more experienced readers, vocabulary learning was improved when compared with the separated format that permitted the more experienced readers to ignore vocabulary. It was argued that efficiency of instruction using annotations depended on the extent to which annotation presentation formats imposed an extraneous cognitive load. The same presentation format might facilitate performance or interfere with performance either through split-attention or redundancy effects, depending on learners' reading expertise. (Yeung, 1999)

From students' perspective, Jacobs, Dufon and Hong (1994) administered their questionnaire to 111 students and asked them where they preferred to have the annotations/glosses located: in the margins, at the bottom of the page, or at the end of the text? The participants indicated a near unanimous preference for marginal glosses (similar to the roll-over format in online reading) over those placed in locations more distant from the text. It was explained by the researchers that students liked marginal glosses the best because their textbooks used this format. Another reason may be that marginal glosses can be accessed faster due to their

proximity to the annotated words. Indeed, three students told the researchers that they preferred the glosses to be inserted in the text, namely, embedded, immediately following the glossed item.

Based on CLT, Morrison (2004) examined the effects of annotation presentation formats in electronic learning environments. When cognitive load was not exceeded (e.g. when 5<sup>th</sup> grade students read the 5<sup>th</sup> grade-level reading passage), presentation formats of definitions did not significantly affect comprehension or vocabulary performance among the low, average and high learning expertise groups. However, when cognitive load was exceeded (e.g. when 5<sup>th</sup> grade students read the 7<sup>th</sup> grade-level reading passage), presentation formats of definitions significantly affect vocabulary but not comprehension among the low, average and high learning expertise groups.

In Morrison's (2004) dissertation research, 111 5<sup>th</sup> grade students were divided into four groups; each group read two short passages, including a 5<sup>th</sup> grade-, and a 7<sup>th</sup> grade- level reading. The four groups differed only in how definitions were presented based on the results from running statistical procedures. The control group had no definitions; the in-text group had in-text definitions; the glossary group was supplied with a separate list of definitions; and the roll-over group was provided with hypermedia roll-over definitions. When cognitive load was not exceeded, presentation formats of definitions did not significantly affect comprehension or vocabulary performance among the groups. However, when cognitive load was exceeded, significant different effects of presentation formats of hypertext annotations have been found among the four groups.

The roll-over presentation method demonstrated the best vocabulary and comprehension performance across reading expertise levels. It was claimed that hypermedia roll-over presentation format presented least overall cognitive load, and that it would perform best over

the widest variety of reading expertise due to the fact that part of the control of using annotations was shifted from instructional designers to learners. In other words, the roll-over presentation format *per se*, was most effective in enhancing vocabulary and comprehension for elementary students. (Morrison, 2004)

To sum up, Yeung (1999) compared the use of integrated and separated annotation presentation formats between younger and older readers in traditional reading and found some interaction between annotation presentation format and age-related reading expertise. On the other hand, Morrison's (2004) study related to hypertext annotation presentation formats focused on a specific age group of subjects, i.e., the younger elementary students, all between 10- and 12-years old. Based on the age-related difference in working memory, in cognitive styles and strategies as cited by Morrison and Yeung, it is of equal importance to examine the different presentation formats of hypertext annotations on older learners, for example, undergraduate students' learning.

### Learner Control

Learner control is operationally defined in this study as the degree to which learners feel they have control over accessing or using annotations, based on a review of literature related to learner control with respect to the choice of content, path, and pace (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988). "Cognitive perspectives are unified in their belief that perceived control over task engagement and outcomes is a critical influence on motivation" (Schunk, 2004, p.369). Moreover, according to Maehr (1984), motivation and learning are

mutually causal. Following is a review of the construct of learner control as related to learning, cognitive load, and hypertext annotation presentation formats.

### *General Cognitive Perspectives on Control*

One cognitive perspective on control is developed by Rotter (1966) and his associates. Arising from his Social Learning Theory (1954), Rotter's concept of locus of control referred to a person's very general, cross-situational beliefs about what determines the reinforcement they get from life. Further Rotter claimed that locus of control is a result of the history of reinforcement patterns experienced by an individual.

According to Rotter (1966), people can be classified along a continuum from very internal to very external in terms of such beliefs. A number of studies have shown individual differences in locus of control by using locus of control tests. At one extreme are internal locus of control people, often referred as Internals, who have a high General Expectancy (Rotter) believing they can control the likelihood of receiving reinforcements through their behavior. At the other extreme are external locus of control people, also termed as Externals, who have a low General Expectancy and do not see as much a causal link between their behavior and the prospect of being rewarded. Instead, the Externals believe that reinforcements are due to luck, fate or under the control of powerful others (Rotter; Smith, 2003).

Researchers have also examined the relationship between locus of control and academic achievement. Students having internal locus of control believe they can control what they learn and perform, as well as the consequences of their actions (Schunk, 2004). As a result, the internal locus of control enhances students' motivation, persistence and success in learning. For example,



internal locus of control students spent more time on homework and studied longer for tests (Anderman and Midgley, 1997; Findley & Cooper, 1983). However, some students have low sense of control over their capabilities and outcomes of their actions; in other words, they generally have external locus of control, which affected their motivation (Bender, 1995), and resulted in their giving up of study and academic failure (Anderman and Midgley).

DeCharms' (1968) concept of personal causation provides another cognitive perspective on perceived control. Originated from Heider's locus of causality for behavior, the "perception of the locus of causality as internal or external to the action is the cornerstone of attribution theory" in social psychology (DeCharms, 1984, p. 278). The theoretical bases of DeCharms' personal causation are built upon the attribution theory, different from Rotter's (1966) concept of locus of control as reinforcements that arises from the Social Learning Theory.

However, similar to Rotter's (1966) categorization of people along the continuum from very internal to very external in terms of locus of control, DeCharms (1984) characterized people as more or less "origin" (p.278) and situation as more or less origin-enhancing . On the negative end of the continuum, people's experience of external locus of causality for behavior, dubbed as the "pawn" experience (p. 278), led to a feeling of being externally pushed around, controlled or alienated. On the positive end of the continuum, the internal locus of causality for behavior implies a sense of choices, freedom, responsibility and ownership. It was further explained that we are all origins some of the time and pawns some of the time: some situations and training can change our perceptions and experiences of the locus of causality as internal or external.

DeCharms (1984) reported his experiment results about the impact of the origin enhancement training on students' motivation and academic achievement scores. Based on a four-year longitudinal study of low-income black elementary schoolchildren, it was found that

students received the personal-causation-training increased their origin scores. Their language and arithmetic skills were also enhanced during the first year while absences and tardiness were significantly reduced.

Further DeCharms (1984) advocated that teachers can become important agents of origin influence. He measured locus of control and origin of eighty-five teachers and reported that high-origin teachers had higher means of student academic scores than did low-origin teachers. To enhance students' origin, teachers must believe that they themselves can be origins and must apply this attitude even to "the most recalcitrant" of students (p. 306). The second thing that teachers can do is to pursue "the optimum amount of structure to fit the class's and, when possible, the individual's needs" (p. 306) by "1) giving carefully conceived choices and 2) by creating an atmosphere that encourage responsible pupil-influence attempts and independent activity" (p. 307).

Skinner, Wellborn and Connell (1990) also suggested that teachers can influence students' perceived control, which is directly and indirectly related to students' school performance. Unlike Rotter's (1966) locus of control and DeCharms' (1968) personal causation concepts that assessed people's beliefs about internal and external reinforcements or causes in a single, bipolar dimension, Skinner, Wellborn and Connell proposed three separate dimensions of students' beliefs about internal and external factors as sources of perceived control:

- (a) Strategy beliefs...expectations about "what it takes for me to do well in school";
- (b) capability beliefs...expectations about whether "I have what it takes"; and
- (c) control beliefs...expectations about "whether or not I can do well in school" without reference to specific means. (p.23)

Using path analyses of the antecedents and consequences of perceived control for an elementary school sample, both positive and negative perceived control were found to be

significantly related to children's engagement in school, grades and achievement scores (Connell & Wellborn, 1991; Skinner, Wellborn & Connell, 1990). Earlier, based on a series of studies related to perceived control in aversive situations (e.g., electric shock and noise), Glass and Singer (1972) reported the effect of learner control on reducing anxiety and increasing tolerance. According to them, perceived control reduced anxiety, and helped people tolerate aversive situations. Moreover, with the perception of control, post-noise or electric shock performance errors were also reduced.

#### *Learner Control in View of Self-Determination Theory (SDT)*

According to SDT (Ryan & Deci, 2000a; 2000b) and a motivational analysis of self-system processes (Connell & Wellborn, 1991), competence, autonomy, and relatedness are our three fundamental psychological needs “that appear to be essential for facilitating optimal functioning of the natural propensities for growth and integration, as well as for constructive social development and personal well-being” (Ryan & Deci, 2000a, p. 68). For example, the relationship between motivation and the needs for competence and autonomy was elaborated by Ryan and Deci as follows:

Feelings of competence will not enhance intrinsic motivation unless accompanied by a sense of autonomy ... Thus... people must not only experience competence or efficacy, they must also experience their behavior as self-determined for intrinsic motivation to be in evidence. This requires either immediate contextual supports for autonomy and competence or abiding inner resources that are typically the result of prior developmental supports for perceived autonomy and competence. (p. 71)

Contextual supports for autonomy and learner control refer “to the amount of choice provided by teachers and parents and to helping children connect their behavior to their own personal goals and values” (Connell & Wellborn, 1991, p. 56). Choice and other opportunities

for learner control were found to enhance intrinsic motivation. Thus, teachers and parents who are autonomy supportive (in contrast to controlling) help children become more intrinsically motivated (Deci & Ryan, 2000b) and improve students' learning, performance and persistence (Vansteenkiste et al, 2004).

According to Arts, Gijsselaers, & Segers (2002), learner control is also an important dimension of Problem-Based Learning (PBL): "The claimed effects of a higher degree of student control...are intrinsically highly motivated students and more active and autonomous students" (p. 471). For example, second-year undergraduate students who gained more control over their learning process and met in their teams, independent of tutor guide, were as effective in identifying learning issues as students who were tutor-guided and given less control. In the quasi-experimental comparative study of a redesigned PBL marketing course, the second-year college students were given increased control over their tasks as they worked more independently from their tutors in small, self-steering teams. Their grades from completing a case study at the end of the course indicated that the redesigned PBL-format contributed significantly to improved cognitive gains, compared to the regular PBL-setting.

Moreover, support for learner control via an Internet information search based program has proved to be effective in changing students' view of learning towards more autonomy in an academic translation course (Yumuk, 2002). Ninety third-year English-speaking translation students at a university in Turkey used the Internet to select, analyze, evaluate and apply relevant information to enhance the accuracy of their translations. Based on the analysis of pre- and post-course questionnaires, post-course interviews and information recorded weekly in a diary by the teacher, it was revealed that the majority of the students viewed learning more meaningfully,

partly because the use of the Internet in academic translation courses encouraged learners to view themselves as having more control to enhance their accuracy in translations.

### *Learner Control in View of CLT*

Various motivational theories that discuss the construct of learner control unanimously claim that appropriate learner control has positive impact on learning. In cognitive load research, learner control is studied as related to cognitive load and learning (Morrison, 2004; van Merriënboer, Schuurman, de Croock, & Paas, 2002). For example, preliminary indications of the relationship between learner control and cognitive load have been reported by van Merriënboer, Schuurman, de Croock, & Paas and Morrison. Giving learners control over the type of problem formats might increase task involvement, thus more germane cognitive load was invested in learning and better performance entailed (van Merriënboer, Schuurman, de Croock, & Paas). On the other hand, according to Morrison, the roll-over annotation format gave learner control over what annotations to access when deemed necessary, thus reducing the extraneous cognitive load caused by the redundancy effect.

van Merriënboer, Schuurman, de Croock, & Paas (2002) randomly assigned twenty-six first year undergraduate students to three experiment condition groups to learn an introductory computer programming module. The module was computer-based and had three instruction formats for the experiment conditions: (1) a completion problem format, (2) a conventional problem format, and (3) a learner-controlled format in which learners may choose between the completion problem format and the conventional problem format.

In numbers of completed assignments, both the conventional and the completion group and the conventional and the learner control group differed significantly; there was no significant difference between the completion and learner control group. For the perceived amount of mental effort related to the practice problems, the highest cognitive load was reported by the conventional group, followed by the learner control group and the completion group, but only the conventional and completion groups differed significantly. Finally, for the proportion of correctly identified plan errors in the transfer test, the learner control group had the highest transfer, significantly different from the conventional group. One possible explanation for the learner control group's superior transfer was that giving learners control over the type of problems might increase their task involvement, so that they were more inclined to invest germane cognitive load in learning.

Morrison (2004) found the roll-over presentation format of hypertext annotations to be more effective in electronic learning environment for younger or less experienced readers, implying that it gave learner control over what annotations to use, thus presented least extraneous cognitive load, when compared to the split-attention effect of online glossary annotations and the redundancy effect of in-text annotations. Specifically, learners with high expertise can read the original text smoothly without touching or paying attention to the hidden annotations, while learners with low expertise do not need to search the meaning for the highlighted concepts in the glossary because the roll-over presentation format makes the explanatory note so proximate to the original concept that only a little extra attention is required in the process of searching for explanations. When learners are given the control and choice to select the annotation format using the roll-over format, it has been found that their overall

cognitive load was the lowest when compared with other groups that were supplied with embedded or online glossary annotation formats.

In summary, the roll-over annotation format seems to have the potential to keep the balance between split-attention and redundancy effect by giving learners some control to only select the annotations that deemed necessary, thus optimizing cognitive load and learning (Morrison, 2004). In other words, learner control was negatively related to cognitive load: learning as the roll-over annotation presentation format gave learners control led to a reduced extraneous cognitive load. This dissertation is to explore how college students react to different hypertext annotation presentation formats, in terms of their perceptions of control during reading the same web-based text which has different annotation presentation formats.

### Research Questions

Annotations at the word level designed for information selection (Wallen, 2002) are presented in four different ways for the four treatment groups in this study: 1) embedded/in-text, 2) online glossary, 3) roll-over, & 4) a combination of the multiple formats. The control group was provided with no annotations. Therefore, there are altogether five different experiment condition groups in this study, including four treatment/annotation presentation groups and one control/no annotation presentation group.

The overall research question for the current study is:

Do the groups differ in their cognitive load, learner control and learning (in terms of knowledge recall and comprehension) when they are presented with hypertext annotations in different formats in a web-based educational psychology text?

Following are sub-questions related to students' cognitive load, learner control, knowledge and comprehension in their specific experiment conditions:

1). Do the five groups differ in their perceived cognitive load, as assessed by Yeung, Lee, Pena and Ryde's (2000) Subjective Mental Workload Survey? Simply put, is the roll-over presentation format a more effective one as indicated in Morrison's (2004) study also a more effective one for undergraduate students? Based on the age-related difference in terms of working memory, cognitive styles, strategies, recall, and learning, as extensively reviewed in Yeung (1999) and Morrison (2004), it is expected that the result from this study for college students would be different from that of Morrison's study for the 5<sup>th</sup> grade less experienced readers, where it was claimed that the roll-over format was the more effective format due to its reduced extraneous cognitive load.

2). Do the five groups differ in their learning, as measured by their knowledge score from matching annotations with the original concepts? Based on results from some prior research related to the effectiveness of annotations/glosses on vocabulary learning, it is expected that the groups provided with annotations will outperform the no annotation group in their knowledge about the annotated concepts. Furthermore, according to Jacobs, Dufon and Hong (1994), the marginal annotation presentation format in traditional textbook reading, similar to the roll-over format in online learning, was preferred and proved to be more effective by Morrison (2004) in online reading. Therefore, it is expected that the roll-over format group will outperform other peers in the current study.

3). Do the five groups differ in their learning, as measured by their comprehension from answering multiple choice items about the main idea of the educational psychology text content? It is expected that the groups with annotations will outperform the no annotation group in



comprehension. Furthermore, based on students' preference for the marginal annotation presentation (Jacobs, Dufon and Hong, 1994) or the similar roll-over format in online learning, and Morrison's (2004) positive implications about the roll-over format in facilitating reading comprehension, it is expected the roll-over format group will outperform other peers in comprehension.

4). Do the four treatment groups each provided with a different annotation presentation format differ in their perceived learner control? Different cognitive perspectives have resulted in the development of various concepts related to control, such as locus of control by Rotter (1966), personal causation by Decharms (1968), self-system processes by Connell and Wellborn (1991) and, more recently, STD by Ryan and Deci (2000a;b). In this study, different annotation presentation formats may give learners different control over what annotations to access, and when and how to access annotations. It is expected that learners may feel different degree of control, as generated by different annotation presentation formats.

5). Does learner control correlate with cognitive load as generated by the four annotation presentation formats? Preliminary indications of the relationship between learner control and cognitive load have been reported in van Merriënboer, Schuurman, de Croock, & Paas (2002) and Morrison (2004). It is expected that there will be a significant relationship between learner control and cognitive load.

6) Does learner control correlate with knowledge score in the four annotation presentation groups? Various motivational theories emphasize the importance of learner control in learning. It is expected that learner control correlate with knowledge score in the four annotation presentation groups in this study.

7) Does learner control correlate with comprehension score in the four annotation presentation groups? Since comprehension score is the other indicator of students' performance in this study, it is also important to look at the correlation between learner control and comprehension score. It is expected that learner control correlate with comprehension score in this study.

## CHAPTER THREE: METHODOLOGY

### Participants

Students who took the undergraduate educational psychology class on the main campus of a large southern state university from the college of education in spring 2006 were recruited during class to participate voluntarily in the study. Participants were randomly assigned to one of the five experiment condition groups: 1) embedded annotation format, 2) multiple annotation formats, 3) no annotation format, 4) online glossary annotation format, & 5) roll-over annotation format.

The sampling method used in the study was purposive sampling (Patton, 1990), because the educational psychology class was a required course for all the undergraduate students in the college of education. By recruiting students in the educational psychology classes to participate in this study, a wide representation of the population for the study might be achieved, which were, in the current study, the college of education undergraduate students on the main campus of the university.

Five instructors teaching seven of the educational psychology classes granted permission to the researcher to recruit their students to conduct the study during or before their class meeting. Most instructors used this research activity as part of in-class or additional activities and encouraged their students to participate by offering 3-5 bonus grade points.

There were a total of 229 participants who agreed to participate in the study by submitting their informed consent form online. In total, there were 205 submissions of the survey

and 192 submissions of the quiz. Following is a brief description of the demographics of the participants so as to present a big picture of the population of this study.

Participants were mainly composed of female, Caucasian, 18-25 year old, college of education students in their 3rd year of undergraduate study. The percentage of the gender, age, year in school and race/ethnicity of the participants were as follows: 17.6% male, 82.4% female; 88.8% 18-25 years old, 11.2% above 25 years old; 71.7% junior students, 22% senior students, 6.3% other grade level students; and 3.4% Asian/Pacific Islander, 8.3% Black/African American (not Hispanic), 77.6% Caucasian/White (not Hispanic), 6.8% Hispanic, 3.9% Native American and other. In addition, 69% of the students reported having pre-existing knowledge while the rest 31% of the students reported having almost no pre-existing knowledge of the web-based content in this study.

### Informed Consent

An informed consent form (Appendix S: Informed Consent) was submitted to and approved (Appendix T: Approval Letter) by the Institutional Review Board (IRB). The form described the purpose, process, confidentiality, contact information for questions related to the study as well as participants' risks, benefits/compensation, rights, etc. It was assumed that most of the undergraduate students from the college of education in the university would be 18 years or older, however, to verify this demographic information, students were asked to indicate that they are 18 years or older when they filled out the consent form. Another key item on the consent form in alignment with the IRB asked students to fill in their full name on the online form to indicate that they agreed to be a voluntary participant.

When the study began, students in each class were instructed to read and submit the online informed consent form if they chose to participate. Most students in the classes were willing to participate and their forms were electronically submitted to the researchers' online data collection account via the Form Manager software. Out of the 229 submissions of the online consent forms, nine were eliminated because the participants either did not fill out their full name or did not indicate that they were 18 years or older.

When participants submitted their informed consent forms online, participants were given the opportunity to download an electronic copy of the informed consent form for their own records. After they submitted their consent forms, they were free to withdraw consent and discontinue participation at any time without consequence. Some students chose not to participate and a few discontinued their participation.

Participants' informed consent information was downloaded to the researcher's computer and saved as a password protected file. The researcher compiled a name list of the participants in each class and sent via email to each instructor as a record of their participation. Then, the researcher matched participants' responses to the survey and the quiz, cross-checking their names and/or Group ID codes. In other words, the survey and the quiz data were compiled and coded to protect participants' privacy. Finally, the data was anonymously analyzed by the researcher.

## Design

This study used Campbell and Stanley's (1963) Type 6 Design, namely, the Posttest Only Control Group design (p. 25-26). Using this design method, particularly via random assignment

of participants among the five experiment condition groups, individual differences of participants were minimized within the groups and differences across the annotation presentation formats groups *per se*, if there were any, would be revealed. Again, the control group was the no annotation group, while the other four annotation groups were those presented with annotations in different formats: embedded, multiple, online glossary and roll-over.

### Materials and Instrumentation

Materials and instruments consisted of a reading passage including annotations for eight key concepts (Appendix A-E), a survey (Appendix F & G: Learner Survey) about participants' responses to the use of their assigned annotation format, a quiz (Appendix H: Learning Quiz) about participants' learning from the reading passage with different annotation formats, instruction sheets (Appendix I-M: Instruction Sheet), and brief training materials on how to use the annotation format (Appendix N-R: Training). The researcher created and modified the materials and the instruments based on a review of literature.

All the materials and instruments were reviewed and edited by the undergraduate education psychology course instructors and other peers in the field. Macromedia Dreamweaver (MX 2004) was used to create web pages for all the materials and the instruments except the instruction sheets, which were printed out and posted with a group ID on each of them before they were randomly assigned to participants. The online consent form, training, reading, survey and quiz material were uploaded to the researcher's server account and published in the researcher's website assigned by the university.

### *Reading Passage*

Based on two assigned textbooks (Eggen & Kauchak, 2004; Woolfolk, 2004) that have been established for the course on educational psychology, the researcher crafted one web-page text (approx. 800 words) related to the Erikson's Developmental Theory. Additionally, the researcher selected eight annotations for eight key concepts from one textbook and used them for the treatment groups. The text and the eight annotations (See Appendix A-E) were reviewed and edited by the course instructors.

Five versions of the web-based text were created, using five different website addresses. Based on the specific website address listed on their instruction sheet, each participant logged on to their assigned version of the text, accessing annotations in a specific format. The four treatment groups were provided with the same eight key concept annotations using one of the four formats: 1) Embedded annotations (EA), which refers to additional verbal explanations embedded in the original text; 2) Online glossary, (OG) which appears as a pop-up window adjacent to the original text window and contains a listing of definitions or explanations for key concepts or terms in the original text; 3) Roll-over annotations (RA), which are hidden explanatory notes, but will pop-up when the mouse is moved or rolled over to touch the highlighted original concept or term; and 4) Multiple annotations (MA), which are annotations that are repeatedly provided to learners in an embedded format, an online glossary format, and a roll-over annotation format. The no annotation (NA) control group was however, simply not provided with any annotations.

### *Instruments*

A short survey with thirty items was created mainly to measure cognitive load and learner control. The components of the survey varied slightly between the treatment groups and the control group. Both the treatment groups and the control group had sixteen items for cognitive load, two items for computer proficiency, two items for prior knowledge of the text and four items for participants' demographic information.

The only difference between the survey for the treatment/annotation-presented group (see Appendix G) and the control/no-annotation group (see Appendix F) was that the former included six learner control items, while the latter had six filler items related to the relevance of the text. This way all the five groups had the same amount of survey items.

#### *Measure of Cognitive Load*

Sixteen items for the subjective measure of cognitive load were adapted from Yeung, Lee, Pena and Ryde's (2000) Subjective Mental Workload Survey, which includes four items for each of the four sub scales: Difficulty (D), Incompetence (I), Negative Affect (A) and Lack of Effort (E). Permissions were granted via email.

According to Yeung, Lee, Pena and Ryde (2000), "higher Difficulty and Incompetence scores coupled with higher Effort scores, that is  $(D \times I)/E$ , together with higher Difficulty and Incompetence coupled with lower Negative Affect, that is  $(D \times I)/A$ " (p. 6) would result in a higher mental workload. Simply put, Mental Workload, or termed as Cognitive Load in this study equals  $(D \times I)/E + (D \times I)/A$ , while D stands for the score of Difficulty, I represents the score of Incompetence, A refers to the score of Negative Affect, and E equals the score of Lack of Effort. The reliability of the cognitive load measure in Yeung, Lee, Pena & Ryde's study



(2000) was reported based on the individual reliability of the sub measurement of the four constructs of cognitive load, including Difficulty ( $r = .84$ ), Incompetence ( $r = .93$ ), Negative Affect ( $r = .78$ ), and Lack of Effort ( $r = .80$ ).

As a sample of the total sixteen survey items related to cognitive load, following are four selected survey items, each representing one of the four sub-scales: Negative Affect, “I was very interested in reading the text”; Difficulty, “I had no difficulty in reading the text”; Incompetence, “I understood what I read”, and Lack of Effort, “I paid attention throughout the reading”. For all the sixteen survey items on cognitive load, a 5-point symmetrical rating scale, ranging from 1 “strongly disagree” to 5 “strongly agree” was used (Yeung, Lee, Pena & Ryde, 2000). The reliability of each sub-scale of the cognitive load instrument in this study was calculated to be between .74 and .79, using the Cronbach Alpha model in SPSS 12.0.

#### *Measure of Learner Control*

Six items for measure of learner control were modified from Harris, Bolander, Lebrun, Docq, & Bouvy’s questionnaire (2004) and edited by the researcher’s dissertation committee. No permission was requested when modifying the learner control measure because Harris et al’s questionnaire was already in the public domain. The reliability of the learner control measure in Harris et al’s (2004) research was not reported.

The learner control measure in this study used a 5-point symmetrical rating scale, ranging from 1 “strongly disagree” to 5 “strongly agree”. Three sample items were stated below: 1) “I had control over what explanations to access and read for new terms in the text”; 2) “I had choices over how to access and read explanations for new terms in the text”; and 3) “It was up to me when to access and read explanations for new terms in the text”. The reliability of the measure of learner control in this study was calculated to be .85 (Cronbach Alpha).

## *Quiz*

A learning quiz (see Appendix H) with 28 items was created and revised by the researcher and one course instructor. The quiz was designed in a systematic way as described in textbooks (Kubiszyn & Borich, 2003; Linn & Gronlund, 2005; Nitko, 2004).

Based on an analysis of the web-delivered content and learners' prior knowledge, three learning objectives were generated for the web-delivered text within the testing time: 1) learners should be able to recall the key concepts of the text, by matching them with their explanations/annotations; 2) learners should be able to identify the main idea of the text; and 3) learners should be able to comprehend Erikson's human development theory as described in the web-delivered text.

To be consistent with the first learning objective, the researcher created eight matching-items that tested participants' knowledge in terms of their recall of the annotations for key concepts, similar to vocabulary learning tested in prior studies. For example, for the concept of *identity*, the matching explanation is "organizations of individual's beliefs, abilities, etc into consistent self image". The reliability of the eight matching-items in the quiz was calculated to be .75 (Cronbach Alpha).

Next, four items that focused on students' understanding of the main idea of the text (i.e., the second learning objective of the web-delivered text) were selected from the test bank frequently used by the instructor in her former classes. For example, one multiple-choice item testing the main idea of the text is "Erikson's stage theory is mainly concerned with..." and the four choices are respectively a) "behaviors and their consequences"; b) "the development of moral values"; c) "the formation of a personal identity"; and d) "the process of acculturation in school settings".

Based on the last learning objective, the remaining ten items assessed students' understanding of each stage of Erickson's theory, also drawn or adapted from the instructor's test bank. One example of the multiple-choice items is illustrated as follows: "According to Erikson, if a child doesn't resolve a stage's crisis in a healthy way, the child is apt to: a) encounter problems with resolutions of later crises; b) forget the crisis and progress normally; c) remain at the unresolved stage until the crisis is resolved; and d) resolve the crisis at a later stage." The reliability of the fourteen multiple-choice items in the quiz was calculated to be .35 (Cronbach). It should be noted that the low internal consistency for the comprehension test "sets an upper bound limit on its correlation with other variables; hence, these relations may be attenuated" (Skinner, Wellborn, Connell, 1990, p. 25).

However, as pointed out by Kubiszyn and Borich (2003), content validity evidence of the quiz can be established when the quiz items are designed to match instructional objectives. Moreover, the course instructor review of the quiz can confirm its content validity, to a certain degree.

### *Instruction Sheets and Training*

Material instructions for the participants to complete the study have been created on an instruction sheet with five different versions for the five different experiment condition groups (see Appendix I-M), each of which listed the same six steps for the participant to take in the same order. Each group was linked to its own annotation format (embedded annotation, multiple annotations, no annotation, online glossary and roll-over annotation) for reading the web-based text and later to one of the two different learner survey websites (one for control group and the

other for the four annotation treatment groups) when they followed instructions for completing their learner survey.

For each class (with approximate 30 participants), 35 instruction sheets with group IDs (e.g., ranging from 1001 to 1007, 2001 to 2007, 3001 to 3007, 4001 to 4007 & 5001 to 5007) were thoroughly mixed together and randomly assigned to the participants. In doing so, a roughly equal number of participants were assigned to each annotation group and each participant was guaranteed to have a randomly assigned Group ID (or annotation format group).

Brief online training material illustrated how to access a specific annotation presentation format assigned to the participant. There were five versions of annotation format training materials on line (See Appendix N-R), using five different website addresses. Based on the specific website address listed on their instruction sheet, each participant logged on to their assigned training version to practice how to access and use the specific annotation format.

### Pilot Study

A pilot test was designed and administered at the end of spring 2005 in one undergraduate class in college of education, with permissions granted to the researcher by the instructor. Students were recruited during class to participate voluntarily in the pilot study and were randomly assigned to one of the five annotation presentation format groups. The purpose of the pilot test was to enable the researcher to implement the entire research design in a real learning setting. The pilot test aided in troubleshooting and helped in the revision of the study in several aspects.

First, because only half of the pilot test participants completed the pilot study in twenty minutes, thirty minutes was allocated for the actual study to ensure most of the participants could complete it. Second, it was observed that some students changed the window width of the web-page text during their reading in the pilot study. Therefore, in the actual study, all the five versions of the web-page text were individually put in a table with the same width. In doing so, the window width of the text would be the same for each participant. Third, based on participants' feedback that the instructions on the instruction sheet were not clear in the pilot study, the researcher reformatted the instruction sheet, using more space between steps and capitalizing the important words. Moreover, the instructor monitored each step of the actual study, making sure every participant was able to follow the instructions. Fourth, it was noticed that some students used the text as a reference when they answered the quiz questions. To better control for similar intervening variables in the actual study, the short survey, rather than the quiz, was conducted following reading. This way, when the participants were doing the survey, the researcher was given enough time to remove the text from the researcher's website so that participants were not able to refer to the text website.

Another reason for moving the survey ahead of the quiz was due to the fact that some students finished their reading faster than other students. They did other reading, played online games or were engaged in other unrelated activities while waiting to begin the quiz. The unrelated activities could distract them from the content and thus impact their quiz results. By moving the survey ahead of the quiz, the fast-readers were allowed to start the survey immediately after their reading so that they were not distracted by other activities; meanwhile the slow-readers were able to finish their reading using some of their survey time. When the fast-readers finished the survey, the whole class was instructed to do the quiz at the same time. This

way, students were not distracted during the quiz by other unrelated activities. Also every student was allowed enough time to read the text and to do the quiz, although some slow-readers might not get enough time to finish their survey.

A short survey period between the reading and the quiz is supposed to cause an overload learning situation for participants because they are required to finish the survey first before they can complete their quiz. In other words, when they do their quiz, they are overloaded with the information of the survey, in addition to what they remember from reading the text. As stated previously, the roll-over format was more effective than other formats only in an overload learning situation (Morrison, 2004), that is, when the 5<sup>th</sup> grade students read the 7<sup>th</sup> grade-level material; Otherwise, all the formats had no difference. It is therefore expected that the overload learning situation induced by the survey would be a desired situation for the current study to test if any type of annotation presentation format would also be more effective for college students in a similar overload learning situation.

#### Data Collection Procedure

Based on a notice from the instructors that the web-based text outlining the Erikson's Developmental Theory would not be covered by the end of the third week of the spring semester 2006, the data collection was scheduled for each of the seven participating classes at the beginning of their third week class, between Monday and Thursday. Before students came to class, the researcher and the technical support staff moved laptops to scheduled classrooms. Each laptop was connected with wireless Internet and equipped with a mouse and a battery.

At the beginning of each class, one laptop and an instruction sheet with a group ID was randomly assigned to each student by having them coming up front to randomly get one laptop and an instruction sheet with their group ID posted on it. Next, the researcher briefly introduced herself and invited students to participate in the research. During the instruction about the purpose and the procedure of the study, the researcher emphasized that the reading, the survey and the quiz should be done individually and no references should be used. Then, the researcher demonstrated how to submit the online informed consent form successfully. To focus students' attention on the experiment of reading the web-based text, they were required not to use the keyboard to do unrelated work.

When there were no questions on how to do the study and submit the forms on line, participants were instructed to type the first webpage address printed out on their instruction sheet and log on to the online consent form website. When every participant finished the online submission of the consent form successfully, they were instructed to type the second webpage address to participate in brief training on how to use their assigned annotation format.

After every participant indicated that they were familiar with their assigned annotation format, they were instructed to type the third webpage address and start reading the web-based text using the annotations the way they were trained. Six minutes later, reading was ended and a short online survey began. Five minutes later, the survey was ended and the quiz began. In another ten minutes, the quiz was ended. The laptops were shut down. Together with their instruction sheets, the laptops were returned by participants to the researcher, indicating the study was over in the classrooms. Those students who chose not to conduct the experiment by not submitting the informed consent form or discontinuing their participation in the study did their alternate reading quietly.

### *Special Circumstances in Data Collection Procedure*

Although a pilot test was conducted with a small group of students in one classroom, some special circumstances still arose during the data collection of the actual study in seven different classrooms. First, although each laptop was attached with a mouse, some students chose to use the small keyboard on the laptop for some unknown reason. Moreover, some students decided not to have a mouse attached to their laptop throughout the study. Second, a few students could not successfully submit their survey and/or quiz forms on line due to some unknown reason either on the part of the participants or due to errors related to the university's Form Manager software. Third, two classes had to use desktop computers during the study due to a limited number of laptops in the specific classroom building. In a word, some uncontrollable variables existed during the study implementation, because thirty or more students were simultaneously tested in the use of a web-delivered text. Such factors that existed in the data collection should be identified as confounding factors that might cause some threats to the internal validity of this study.

### Data Analysis

Data was analyzed using SPSS 12.0. One-way analysis of variance (ANOVA) was used when there was a categorical independent variable (with two or more categories) and an interval dependent variable. On the other hand, two-way ANOVA was used to detect interaction effects between two categorical independent variables on an interval dependent variable. Moreover, correlation analyses were used to explore the association, if any, between any two variables of cognitive load, learning and learner control.



In this study, the different annotation presentation formats were one of the categorical independent variables. Post-hoc analysis included students' content familiarity and computer experience as two other categorical independent variables. Students' cognitive load, learning and learner control were the dependent variable.

## CHAPTER FOUR: RESULTS

As depicted in chapter 2, seven sub research questions were asked in relation to the overall research question about the effect of different annotation presentation format on cognitive load, learner control and learning. In this chapter, I will reiterate each sub research question and report their individual test results. Statistical software SPSS 12.0 was used for all analyses.

### Research Question 1

The first focus of this study was to extend Morrison's (2004) study to examine the effects of different annotation presentation formats on college students' perceived cognitive load in online learning environments. Therefore, the first sub research question of this study was whether the five experiment condition groups differ in their perceived cognitive load. It was expected that the result from this study for college students would be different from that of Morrison's study for the 5<sup>th</sup> grade less experienced readers, where it was claimed that the roll-over format was the more effective format due to its reduced extraneous cognitive load. The cognitive load generated by each specific annotation presentation format for each specific participant in this study was computed using Yeung, Lee, Pena and Ryde's (2000) formula.

Research question 1 had one dependent variable and one independent variable. The dependent variable was cognitive load. The independent variable was the annotation presentation format groups, which had five levels (1=embedded annotation format, 2=multiple annotation formats, 3=no annotation, 4=online glossary annotation format and 5=roll-over annotation format).

### *Test Results for Research Question 1*

Using One-way ANOVA, no statistically significant differences ( $F = .92, p > .05$ , see Table 1) were found among the five different experiment condition groups. My expectation for research question 1 was confirmed, that is, the result from this study for college students was different from that of Morrison's (2004) study. In Morrison's study, the roll-over format was reported to cause least cognitive load for the 5<sup>th</sup> grade less experienced readers. In the current study, however, the five experiment condition groups of college students did not perceive cognitive load differently.

Table 1: Cognitive Load ANOVA Test Result

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	184.03	4	46.01	.92	.45
Within Groups	9057.84	181	50.04		
Total	9241.86	185			

To be specific, as indicated in Table 2, the means difference was not statistically significant between the control group ( $n = 37, M = 10.28, SD = 6.11$ ), the embedded annotations group ( $n = 36, M = 10.57, SD = 5.33$ ), the multiple annotations group ( $n = 37, M = 11.65, SD = 8.60$ ), the online glossary group ( $n = 39, M = 13.06, SD = 8.08$ ) and the roll-over annotations group ( $n = 37, M = 11.76, SD = 6.61$ ).

Table 2: Cognitive Load Means and Standard Deviations

Experiment Conditions	<i>N</i>	Mean	Standard Deviation
Embedded annotations	36	10.57	5.33
Multiple annotations	37	11.65	8.60
Control/No annotations	37	10.28	6.11
Online glossary	39	13.06	8.08
Roll-over annotations	37	11.76	6.61
Total	186	11.49	7.07

A post-hoc analysis focused on the interaction effect between prior knowledge and annotation presentation format on cognitive load. Based on participants' rating of their familiarity with the web-delivered educational psychology text, it was found 31% of the students reported having no pre-existing knowledge of the educational psychology content used in this study while 69% of the students reported having some degree of familiarity with the content. Therefore, participants were divided into two groups: 1) new to the text and 2) familiar with the text.

Using a 5X2 Two-way ANOVA, the result showed that there was a statistically significant interaction effect between prior knowledge and annotation presentation format on cognitive load ( $F = 2.5, p < .05$ ), as illustrated in Table 3. About 6% of the cognitive load difference can be explained by the interaction effect between annotation presentation format and

prior knowledge. Pre-existing knowledge on its own was not found to be statistically significant on cognitive load ( $F = 3.2, p > .05$ ), neither was annotation presentation format itself ( $F = .6, p > .05$ ).

Table 3: Interaction between Annotation Formats and Pre-existing Knowledge

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	790.68	9	87.85	1.83	.06	.09
Intercept	21881.81	1	21881.81	455.70	.00	.72
Familiarity	152.73	1	152.73	3.18	.08	.02
Annotation Formats & Annotation Formats Interaction	116.97	4	29.24	.61	.66	.01
Familiarity	488.98	4	122.24	2.55	.04	.06
Error	8451.18	176	48.02			
Total	33779.86	186				

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Corrected	9241.86	185
Total		

---

As indicated in Table 4, it was further revealed that the group who had pre-existing knowledge perceived the highest cognitive load ( $M = 13.8$ ) when online glossary presentation format was provided and the least cognitive load when no annotation presentation format ( $M = 8.9$ ) was provided. Meanwhile, the group who had almost no prior knowledge perceived the highest cognitive load ( $M = 15.9$ ) when multiple annotation presentation format was provided and the least cognitive load ( $M = 10.1$ ) when embedded annotation presentation format was provided.

Table 4: Cognitive Load of Annotation Presentation Formats based on Prior Knowledge

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Familiarity	Annotation Formats	Mean	Std.		
			Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Familiar with Text	Embedded Annotations	10.72	1.33	8.09	13.35
	Multiple Annotations	9.61	1.39	6.87	12.35
	No Annotations	8.92	1.29	6.38	11.46
	Online Glossary	13.84	1.45	10.99	16.69
	Roll-over Annotations	11.80	1.41	9.01	14.59
New with Text	Embedded Annotations	10.13	2.31	5.58	14.69
	Multiple Annotations	15.89	2.00	11.94	19.84

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No Annotations	15.24	2.45	10.40	20.07
Online Glossary	11.94	1.73	8.52	15.36
Roll-over Annotations	11.69	1.92	7.89	15.48

Likewise, another post hoc analysis of the interaction effect between annotation presentation format and computer experience was conducted based on participants' rating of their computer experience with technical problems in this study. No statistically significant interaction effect was found between annotation presentation format and computer experience ( $F = .3, p > .05$ , see Table 5). However, there was statistically significant difference on cognitive load based on computer experience ( $F = 12, p < .01$ , also see Table 3), although only about 7% (Partial Eta Squared) of the cognitive load difference between the group with computer problems and that with almost no computer problems can be explained by their computer experience in this study.

Table 5: Interaction between Annotation Presentation Formats and Computer Experience

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1292.06	9	143.56	3.18	.00	.14
Intercept	8726.17	1	8726.17	193.19	.00	.52
Annotation Formats	279.76	4	69.94	1.55	.19	.03
Computer Experience	552.45	1	552.45	12.23	.00	.07
Annotation Formats & Computer	56.93	4	14.23	.32	.87	.01

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Experience Interaction			
Error	7949.80	176	45.17
Total	33779.86	186	
Corrected Total	9241.86	185	

---

Furthermore, using Person's Correlation test, it was found that cognitive load was slightly negatively correlated with computer experience ( $r = -.25$ ,  $p < .01$ , see Table 6). In other words, the more computer problems participants experienced, the higher cognitive load participants perceived, or vice versa.

Table 6: Correlations between Cognitive Load and Computer Experience

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		Cognitive Load	Computer Experience
Cognitive Load	Pearson Correlation	1	-.25
	Sig. (2-tailed)	.	.00
	N	186	186
Computer Experience	Pearson Correlation	-.25	1
	Sig. (2-tailed)	.00	.
	N	186	186

---

### Research question 2

The most common objective measurement of cognitive load was students' performance outcomes (Brunken, Plass, & Leutner, 2003), as indicated by their knowledge score and comprehension score in this study. Therefore, research question two looked at if the five groups



differ in their knowledge score. It was expected that the groups provided with annotations will outperform the no annotation group in their knowledge about the annotated concepts. Furthermore, it was expected that the roll-over format group will perform the best in the current study.

*Test Results for Research Question 2*

Using One-way ANOVA to compare the knowledge score means of the five annotation presentation groups, no statistically significant difference was found ( $F = 1.9, p > .05$ , see Table 7). Basically, the five groups did not differ in their knowledge score with statistic significance.

Table 7: Knowledge Scores Based on Annotation Presentation Formats

	Sum of				
	Squares	df	Mean Square	F	Sig.
Between Groups	34.35	4	8.59	1.91	.11
Within Groups	841.73	187	4.50		
Total	876.08	191			

Research question 3

Current research on text comprehension has provided guidelines for not overloading working memory (Plass, Chun, Mayer & Leutner, 2003; Wallen, Plass & Brunken, 2005). Therefore, research question three examined college students’ learning in terms of comprehension,

that is, whether annotations would enhance students' comprehension of the subject matter related to educational psychology.

It was expected that the groups with annotations will outperform the no annotation group in comprehension. Moreover, it was expected the roll-over format group will outperform other format groups in comprehension.

*Test Results for Research Question 3*

Using One-way ANOVA to compare the comprehension score means of the five annotation presentation groups, no statistically significant difference was found ( $F = .84, p > .05$ , see Table 8). In other words, the five groups did not differ in their comprehension score with statistic significance.

Table 8: Comprehension Scores based on Annotation Presentation Formats

	Sum of				
	Squares	df	Mean Square	F	Sig.
Between Groups	11.225	4	2.806	.843	.499
Within Groups	622.145	187	3.327		
Total	633.370	191			

Research question 4

Different cognitive perspectives have resulted in the development of various concepts related to control, such as locus of control by Rotter (1966), personal causation by Decharms

(1968), self-system processes by Connell and Wellborn (1991) and, more recently, STD by Ryan and Deci (2000a; b). In view of CLT, van Merriënboer, Schuurman, de Croock, & Paas (2002) and Morrison (2004) argued that learner control was related to cognitive load and learning.

Therefore, research question four asked if the four treatment groups each provided with a different annotation presentation format differed in learner control. It is expected that learners may feel different degree of control, as generated by different annotation presentation formats.

#### *Test Results for Research Question 4*

Using Univariate Analysis of Variance, it was found that there was a statistically significant difference ( $F = 3.1, p < .05$ ) in learner control among the four annotation treatment groups, as illustrated in Table 9. However, the effect size was very small (Eta squared = .06). In other words, only 6% of the learner control difference among the four annotation treatment groups can be explained by the annotation presentation formats in this study.

Table 9: Learner Control Differences across the Four Annotation Presentation Groups

	Type III					Partial Eta
Source	Sum of Squares	df	Mean Square	F	Sig.	Squared
Corrected Model	112.83	3	37.61	3.09	.03	.06
Intercept	31885.82	1	31885.82	2622.44	.00	.95
Annotation Formats	112.83	3	37.61	3.09	.03	.06
Error	1763.03	145	12.16			

Total	33859.00	149
Corrected Total	1875.85	148

In brief, the multiple annotation presentation format had the highest learner control ( $M = 15.19$ ,  $SD = 3.5$ ), with an approximately equal score to that of the roll-over format group ( $M = 15.16$ ,  $SD = 3.5$ ). The embedded annotation format had the lowest learner control. The online glossary ( $M = 15.08$ ,  $SD = 3.0$ ) was between the lower end of the embedded annotation format ( $M = 13.11$ ,  $SD = 4.0$ ) and the higher ends of the multiple formats and the roll-over format (See Table 10).

Table 10: Learner Control Means and Standard Deviations

Group ID	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Embedded Annotations	36	13.11	3.963	.66	11.77	14.45	6	20
Multiple Annotations	37	15.19	3.479	.57	14.03	16.35	8	20
Online Glossary	39	15.08	2.932	.47	14.13	16.03	8	20
Roll-over Annotations	37	15.16	3.540	.58	13.98	16.34	4	20

Total	149	14.65	3.560	.29	14.07	15.23	4	20
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Although the main effect of the annotation presentation format on learner control was statistically significant as stated above, the major difference was contributed by the embedded annotation group, which was different from each of the other three groups at the statistically significant level of .05 when all the groups were compared pair-wise, as illustrated in Table 11.

Table 11: Comparisons among the Four Annotation Presentation Groups

Annotation Formats		Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference(a)	
					Lower Bound	Upper Bound
Embedded Annotations	Multiple Annotations	-2.08	.816	.01	-3.69	-.47
	Online Glossary	-1.97	.806	.02	-3.56	-.37
	Roll-over Annotations	-2.05	.816	.01	-3.66	-.44
Multiple Annotations	Embedded Annotations	2.08	.816	.01	.47	3.69
	Online Glossary	.11	.800	.89	-1.47	1.69
	Roll-over Annotations	.03	.811	.97	-1.58	1.63
Online Glossary	Embedded	1.97	.806	.02	.37	3.56

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	Annotations					
	Multiple					
	Annotations	-.11	.800	.89	-1.69	1.47
	Roll-over					
	Annotations	-.09	.800	.92	-1.67	1.50
Roll-over	Embedded					
Annotations	Annotations	2.05 (*)	.816	.013	.438	3.664
	Multiple					
	Annotations	-.03	.811	.973	-1.629	1.575
	Online Glossary	.09	.800	.915	-1.496	1.667

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#### Research question 5

Research question five in this study looked at the relationship between learner control and cognitive load (i.e., mental workload). Prior studies by van Merriënboer, Schuurman, de Croock, & Paas (2002) implied that learner control increased germane cognitive load and Morrison (2004) claimed that learner control reduced extraneous cognitive load. To investigate the relationship between learner control and cognitive load calculated by Yeung, Lee, Pena and Ryde's (2000) mental workload formula, research question five asked if there was relationship between learner control and overall cognitive load when different annotation presentation formats were used. It was expected that there will be a significant relationship between learner control and overall cognitive load.

*Test Results for Research Question 5*

Using Person’s Correlation test, it was found that there was statistically significant relationship between cognitive load and learner control ( $r = -.22, p < .01$ , see Table 12 below). Furthermore, the relationship between learner control and cognitive load was somewhat low negative relationship. The higher learner control, the lower cognitive load (mental workload) induced by the different annotation presentation format.

Table 12: Correlations between Learner Control and Cognitive Load

		Control Total	Cognitive Load
Control Total	Pearson Correlation	1	-.22
	Sig. (2-tailed)	.	.01
	N	149	149
Cognitive Load	Pearson Correlation	-.22	1
	Sig. (2-tailed)	.01	.
	N	149	149

Research question 6 and 7

Prior studies indicated that learner control facilitated learning (Connell & Wellborn, 1991; Morrison, 2004; Skinner, Wellborn & Connell, 1990; van Merriënboer, Schuurman, de Croock, & Paas, 2002). Research question six and seven respectively examined if there was a relationship between learner control and knowledge score, and that between learner control and comprehension, when the four different annotation presentation formats were used.

*Test Results for Research Question 6 and 7*

Using Person's Correlation test, it was found that there was statistically significant relationship between learner control and knowledge score ( $r = .19, p < .01$ , see Table 13 below). Furthermore, the correlation between learner control and knowledge was a low but positive relationship, in other words, the higher learner control the specific presentation format had, the higher knowledge score the specific presentation format group gained.

Table 13: Correlations between Learner Control and Knowledge

		Control Total	Recall Total
Control Total	Pearson Correlation	1	.19
	Sig. (2-tailed)	.	.02
	N	149	149
Recall Total	Pearson Correlation	.19	1
	Sig. (2-tailed)	.02	.
	N	149	154

However, it was revealed that there was no statistically significant relationship between learner control and comprehension score ( $r = .08, p > .05$ , see Table 14 below). In short, there was no statistically significant relationship between learner control and comprehension score of the four different annotation presentation groups.



Table 14: Correlations between Learner Control and Comprehension

		Control Total	Comprehension
Control Total	Pearson Correlation	1	.09
	Sig. (2-tailed)	.	.30
	N	149	149
Comprehension	Pearson Correlation	.09	1
	Sig. (2-tailed)	.30	.
	N	149	154

## CHAPTER FIVE: SUMMARY AND CONCLUSIONS

This dissertation study was intended to increase our understanding of the effects of different annotation presentation formats on college students' perceived cognitive load, knowledge recall and comprehension, and learner control from reading a web-delivered educational psychology text. This overarching purpose was addressed in seven specific research questions and some post-hoc analyses, which focused on treatment effects on cognitive load, learning and learner control; interaction effects between treatment and individual differences such as computer experience and prior knowledge on cognitive load; and the correlation between learner control, cognitive load and learning outcomes.

In this chapter, I will summarize my test results, identify my study limitations, discuss implications for my study, and suggest directions for future research. For a better organization, I will divide this chapter into three sections to cover the three specific focuses of study related to the use of different annotation presentation formats: cognitive load, learning (including knowledge and comprehension), and learner control. Finally, I will make brief concluding remarks.

### Part 1: Cognitive Load Generated by Different Annotation Presentation Formats

#### *Summary of Test Results*

The test results for the first research question indicated that the five experiment condition groups in this study did not differ in their perceived cognitive load when different annotation presentation formats were used. Simply put, there was no single annotation presentation format effect on cognitive load in this study, confirming my expectations that the impact of different

annotation presentation formats on college students' perceived cognitive load would be different from Morrison's (2004) findings about that impact on elementary students in electrical learning environments. One possible explanation for the discrepancy between the result of this study and that of Morrison's study is that the participants of this study were undergraduate students, most aged 18-25, who were more experienced in the use of computer and became used to various annotation presentation formats in online reading. Thus, the superiority of the roll-over presentation format for the 5<sup>th</sup> grade students was not replicated in this study of older/more experienced learners in electrical learning environment.

From another perspective, the results of this study were somewhat consistent with the findings of Yeung, Jin, and Sweller (1998) and Yeung (1999) related to the interaction effect of annotation formats and reading experience in traditional textbook reading. That is, although there was no annotation presentation format effect on its own in electrical reading environment for undergraduate students, just as there was no single annotation presentation format effect in traditional textbook reading, an interaction effect between annotation presentation format and learners' prior knowledge in online reading was found in a post-hoc analysis for the first research question in this study, similar to the interaction effect between annotation presentation format and learners' reading experience reported by Yeung, Jin, and Sweller and Yeung in traditional textbook reading.

The interaction effect between annotation presentation format and prior knowledge on cognitive load as revealed in this study was more complicated than the interaction effect between annotation presentation format and reading experience in Yeung's study (1999) of traditional textbook reading, probably due to the many more variations of annotation presentation formats used in this study. Specifically, learners with pre-existing knowledge indicated that the no

annotation format caused the least cognitive load probably due to the fact that this group was not provided with redundant explanations. On the other hand, the online glossary and the roll-over presentation format caused the maximum cognitive load due to the inherent split-attention effect of the two formats. Interestingly enough, the multiple and the embedded annotation presentation formats caused less cognitive load than the roll-over and the online glossary annotation formats for this group of participants with pre-existing knowledge. One possible explanation may be that students with pre-existing knowledge just browsed through the text and never bothered reading the explanations embedded in text or presented using multiple formats.

For the group who had almost no pre-existing knowledge in this study, highest cognitive load came from the multiple formats and the no annotation format, while the least cognitive load was caused by the embedded annotation presentation format. According to CLT, the multiple formats caused the redundancy effect by being at one extreme of repeatedly providing explanations for the same key concepts and the no annotation format being at another extreme by providing no explanations for the novice learners. In contrast, the embedded annotation format supported a smooth flow of reading for the novice learners by providing explanations embedded in text for each individual concept. The embedded annotation format was also superior to the online glossary and the roll-over format, probably due to the lack of the split-attention effect, that is, students did not need to split their attention between reading the text and searching for meaning in the online glossary, or between reading the text and moving their mouse over the highlighted words to reveal explanations using the roll-over format.

Another post-hoc analysis looked at if there was a similar interaction effect on participants' perceived cognitive load between hypertext annotation presentation format and learners' computer experience with technical problems. Although no statistically significant

interaction effect was found, the effect of learners' computer experience on cognitive load was revealed to be statistically significant. Therefore, it is argued that computer/technical problems can cause extraneous cognitive load in online learning when different annotation presentation formats were used, just as low verbal ability (Hamilton, 2004; Wallen, 2002) did to some students learning from a scientific text with multifaceted levels of annotations.

#### *Limitations of the Test of Treatment Effects*

Limitations of the treatment include the brief nature of the experiment, and the lack of generalizability of the test results. As stated previously in Chapter 3, the online reading experiment lasted 6 minutes. It is reasonable to question whether the effects of different annotation presentation formats in online reading can be distinguished in such a brief experiment. Due to practical constraints, I could not extend the online reading and other parts of the experiment in the seven participating face- to- face classes to go through a longer experiment time. It would have allowed us to better determine if there were any treatment effects in real classroom instructions or online reading environment if experiments using different annotation presentation formats were conducted within a longer period of online reading.

On the other hand, due to the purposive sampling method (Patton, 1990) used in this study, there were some threats to the external validity or generalizability of the results. A random selection of participants from the population would have a better representation of the population than the afore-mentioned purposive sampling method. In other words, the results of the study could be generalized to the whole population of undergraduate students in the college of education on the main campus of the university had a random selection of participants been used.

Nevertheless, because the undergraduate educational psychology course was a required course for all the undergraduate students in the college of education, by having all the seven classes on the main campus of the university to participate in this study (with valid data collected from 196 students), a wide representation of the population of the study might be achieved, with the results in this study probably reflecting that of the whole population of undergraduate students in the college of education on the main campus of the state university.

### *Implications for Online Course Design*

Although no significant difference was found among different annotation presentation formats *per se* in terms of cognitive load, there was an interaction effect between annotation presentation format and prior knowledge on cognitive load. The implications for the design of online course in college level based on the results of this study included that instructional design should take into account of students' prior knowledge about the course content when annotations were designed for online courses. As stated previously, Darabi and Nelson (2004) also found that presenting new information to learners familiar with the information did not improve transfer and might induce extraneous cognitive load, due to the redundancy effect. Similarly, Lee & Calandra (2004) suggested that some annotations might have caused overload on the average students.

Furthermore, due to the interaction effect of the annotation presentation format and students' familiarity with the course content, it is implied that when annotations were presented for online course content, students' familiarity with the content needs to be considered along with the different annotation presentation formats. As suggested by Knight (1994), variables

such as verbal ability and content familiarity may interact with the effects of annotations, including the annotation presentation format effect, as found in this study.

Also, instructional designers should analyze what technical problems students might come across and be well prepared to provide technical support for online students. Although a much wider access could be provided to students and instructors in terms of when and where to conduct online courses due to the flexibility of Internet and other multi-media systems, technical support should be considered essential and incorporated into the plan, design, delivery and evaluation of such hypermedia courses. Without immediate asynchronous or synchronous technical support available, the computer problems that came up anytime during the course would cause an extraneous cognitive load on the part of the students or instructors, which would hamper learning, and properly increase the drop-out rate of online enrollment.

To sum up, this study and Yeung's (1999) study provided empirical evidence for the interaction effect between the use of annotations and learners' individual differences, contrary to Morrison's (2004) claim about the single annotation format effect in electrical learning environment. Students' computer experience, prior knowledge or verbal ability, as indicated in previous studies by Wallen (2002), and Hamilton (2004), should be considered as important variables that might impact students' cognitive load when different annotation presentation formats are provided in online learning. Ultimately, it is hoped that the empirical evidence from this study will encourage instructional designers to use a comprehensive approach to course design, including considering individual differences among students when designing annotations as a type of scaffolding devices for specific knowledge level students, in both traditional textbook learning and online learning environments.

### *Directions for Future Research*

Students encountered some computer problems when learning from the web-based text in this study, which turned out to have a significant impact on their perceived cognitive load. Moreover, students' pre-existing knowledge was revealed to have an interaction effect with different annotation presentation format that impacted students' perceived cognitive load in this study. Future research related to cognitive load and learning generated by annotations in online education should include students' computer experience and pre-existing knowledge as relevant variables.

It is also recommended that a comparison of the effect of annotation presentation formats on cognitive load should be conducted in a different content area other than learning from a web-delivered educational psychology text. For instance, technical software manuals such as SPSS and Dreamweaver, and websites such as Wikis and Bloggers are widely using roll-over annotations, embedded annotations, online glossary, and multiple annotations for presenting annotations. It would increase our understanding and expand the scope of discussions on annotation presentation formats if future research includes the above-mentioned technical areas.

## Part 2: Learning with Different Annotation Presentation Formats

### *Summary of Test Results*

Research question two and research question three in this study respectively examined the effect of annotation presentation formats on knowledge recall and comprehension. Contrary to my expectations, it was revealed that the five experiment condition groups neither differ in



their knowledge nor in their comprehension scores. Simply put, there was no statistically significant difference among the groups in terms of learning outcomes: groups provided with annotations did not perform better than the group without annotations; furthermore, the roll-over annotation format group did not outperform any other annotation format group.

The results from this study were contradictory to some findings from previous studies but consistent with others in terms of the effectiveness of annotations. Different from what was claimed by Aweiss (1993), Davis (1989), Jacobs, Dufon and Hong (1994) and Knight (1994) that learners with glosses outperformed their peers without glosses, this study did not reveal any statistically significant positive effects of annotations. However, this study had similar findings to those claimed by Yeung, Jin & Sweller (1998) — the explanatory notes condition group did not outperform the no-explanatory notes condition group in terms of vocabulary learning. This study's results were also similar to Davis and Lyman-Hager's (1997) findings, that is, there was no significant relationship between annotations and reading comprehension. Furthermore, the roll-over annotation presentation format did not show any statistically significant difference from other annotation formats for undergraduate students; therefore, Morrison's (2004) conclusions about the superiority of the roll-over annotation format in vocabulary learning and reading comprehension was not confirmed in this study.

#### *Limitations of the Test of Treatment Effects*

One limitation of the test of treatment effects on learning may be caused by the low reliability of the comprehension items. Specifically, the treatment effects of different annotation presentation formats on comprehension may have been confounded by the measurement error of

the comprehension test due to its low reliability. Had time allowed, a pilot test of the measurement would aid in improving the reliability of the fourteen comprehension items. However, as stated previously, some content validity evidence of the comprehension items was established because they were designed to match instructional objectives (Kubiszyn & Borich, 2003) and reviewed by the course instructor. Another potential limitation of the treatment effects may be due to the small sample size in each experiment condition group. On average, there were about thirty five participants per group, which may not have enough power to detect group differences in learning with different annotation presentation format. Therefore, it is suggested that future researchers should pilot-test measurement and recruit more participants for each group when group differences are examined.

#### *Implications for the Design of Annotations and Directions for Future Research*

Based on the results from this study and the mixed findings from previous studies concerning the effectiveness of annotations in knowledge and comprehension, it is clear that effective design of annotations can be very challenging and complicated. As reviewed in Ariew and Ercetin (2004), there may not be a direct relationship between annotation use and reading. In other words, annotations *per se* did not have impact on reading. Other variables, such as learners' verbal ability or proficiency may interact with the effects of annotations. According to Knight (1994), annotations may be more beneficial for low verbal ability and low proficiency learners. In the current study, 69% or the majority of the participants indicated familiarity with the web-delivered content, which might explain why there were no statistically significant relationships between annotations and reading. In future studies when annotations are designed, it is important

to consider other variables such as learners' content familiarity because scaffolding including the use of annotations is needed during the learning process only when content is unfamiliar to individuals (see Lee & Calandra, 2004).

### Part 3: Learner Control with Different Annotation Presentation Formats

#### *Summary of Test Results*

Research question four was intended to test Morrison's (2004) claim about the difference of learner control related to annotation presentation formats. Consistent with Morrison's claims, the result from this study confirmed my expectations about the differences in learner control among the different annotation presentation formats. Nevertheless, there were no significant differences among the multiple annotations format, the online glossary format, and the roll-over annotation format in terms of learner control. The statistically significant difference among the different annotation presentation format groups was contributed only by the embedded annotation format group, based on the pair-wise comparison results. With regards to when, what and how to access annotations, that is, the operational definition of learner control (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988) in this study, the embedded annotations seemed to give students the least choices, thus generating the lowest learner control among the four groups.

Preliminary indications of learner control related to cognitive load were summarized and reported in van Merriënboer, Schuurman, de Croock, & Paas (2002) and Morrison (2004). It was claimed that giving learners control over problem formats might help learners optimize their allocation of cognitive resources for learning (van Merriënboer, Schuurman, de Croock, & Paas). Moreover, Morrison argued that shifting part of the control from instructional designers to learners

and thus reducing the extraneous cognitive load was the key factor that contributed to the effectiveness of using the roll-over annotation presentation format in the 5<sup>th</sup> grade students' mastery of vocabulary and comprehension. The results from research question five confirmed my expectations about a statistically significant relationship between learner control and cognitive load, consistent with results of prior studies related to learner control and cognitive load (Morrison; van Merriënboer, Schuurman, de Croock, & Paas).

Research question six and research question seven respectively examined if there was a relationship between learner control and knowledge, and if there was a relationship between learner control and comprehension when the four different annotation presentation formats were used. The results of the current study partly confirmed prior studies that indicated the positive effect of learner control on learning (Connell & Wellborn, 1991; Morrison, 2004; Skinner, Wellborn & Connell, 1990; van Merriënboer, Schuurman, de Croock, & Paas, 2002). Specifically, there was a positive correlation between knowledge score and learner control, therefore the role of learner control in facilitating learning was supported to some degree. However, no statistically significant relationship was found between learner control and comprehension in this study, somewhat inconsistent with the argument that instructional designers may be able to achieve greater design efficiency by allowing learners to control additional levels of instructional detail (van Merriënboer, Schuurman, de Croock, & Paas). It should be noted though, that the non-significant relationship between learner control and comprehension score may be obscured due to the low reliability of the comprehension items, which set an upper limit on its correlation (Skinner, Wellborn, Connell, 1990) with learner control in this study.

### *Implications for Instructional Design*

The result from research question four indicated that the embedded annotation presentation format had a significantly different impact on learner control when compared pair-wise to the other formats. One implication from this result was that the design of annotation presentation formats should take learner control into account. The embedded format entailed least learner control than the other annotation presentation formats, thus it is recommended not to use the embedded format when higher learner control is deemed appropriate in a specific learning situation.

The result from research question five showed that learner control is negatively related to cognitive load. In other words, higher learner control is related to lower cognitive load in this study, which further confirmed the role of learner control as an important factor that needs to be addressed when online courses are designed. As DeCharms (1984) implied, instructional designers or instructors should try to meet the individual's needs by "giving carefully conceived choices" (p. 307). Specifically, choices should be understandable to students and as personal as possible. On the other hand, the choices should be acceptable to instructors or instructional designers. In the current study, the other three annotation presentation formats including the online glossary format, the roll-over annotation format, and the multiple annotations format each generated significantly higher learner control than the embedded annotation presentation format when they were compared pair-wise with the embedded annotation format. In other words, each of the other three formats can provide a better choice for students than the embedded annotation by giving a higher control to students in terms of what, when and how to access annotations.

Also, based on the result from research question six, the positive relationship was found between learner control and knowledge score, in agreement with findings from previous studies (Connell & Wellborn, 1991; Morrison, 2004; Skinner, Wellborn & Connell, 1990; van Merriënboer, Schuurman, de Croock, & Paas, 2002). In this study, the more learner control perceived by students, the higher knowledge score achieved. The positive relationship between learner control and knowledge score in this study is also supported by the enhancement of academic performance caused by learner control (Vansteenkiste et al, 2004), similar to the positive relationship between learner control and intrinsic motivation (Deci and Ryan, 2000a; b).

It is therefore important that instructional designers provided support for learner control in online education, which will reduce either the extraneous cognitive load (Morrison, 2004) or the overall mental workload as shown in this study. As stated previously, one advantage of online education is attributed to its flexibility because the Web allows students to choose which information they would like to access and when they would like to access it (Becker & Dwyer, 1994; Scheines, Leinhardt, Smith & Cho, 2005). The embedded annotation format used in online course however, does not provide the flexibility or control (Chou & Liu, 2005; Hsiao; 2002; Kinzie, Sullivan, & Berdel, 1988) for students to choose what annotations to access, when to access or how to access them. It is suggested that alternative annotation presentation format including either of the online glossary format, the roll-over format or the multiple annotations format as currently available technologies for presenting annotations should be used to give learners more control or choices for accessing annotations.

### *Directions for Future Research*

Different annotation presentation formats have been incorporated into other media modes of annotations in online learning, including auditory, picture, & video materials. The embedded annotation presentation format was related to less control when compared pair-wise with the other annotation presentation format in this study, using quantitative methods. It is suggested that research methods should be triangulated in future studies to explore how the other three annotation presentation formats were different from the embedded annotation format in terms of learner control. Similarly, a qualitative research on students' perceptions on learner control among the other three annotation formats should be conducted to explore why there is no significant difference among them.

### Conclusion

The current study first examined the use of hypertext annotation presentation formats with respect to their effects on undergraduate students' cognitive load from a web-delivered educational psychology text. An interaction effect on cognitive load between annotation presentation formats and learners' familiarity with the course content was revealed in this study, similar to the interaction effect between the annotation formats and reading experience on cognitive load claimed by Yeung, Jin & Sweller (1998) and Yeung (1999). The implications of this study for research related to CLT are that other variables, e.g., students' familiarity with the content or pre-existing knowledge, should be considered in conjunction with different instruction presentation formats. This study confirmed what Darabi and Nelson (2004) and Le Bohec (2005) have claimed about the redundancy effect caused by pre-existing

knowledge or learner expertise levels. By linking the annotation presentation formats with learners' content familiarity, this study contributes to the ongoing research relating to the redundancy effect generated by CLT.

Computer experience was also found to be related to cognitive load in this study: the more computer problems participants experienced, the higher cognitive load participants perceived, or vice versa. The importance of students' computer experience in online reading, properly equal to that of students' verbal ability in online learning (Wallen, 2002; Wallen, Plass, & Brunken, 2005) or that of students' reading experience in traditional textbook reading (Yeung, Jin and Sweller, 1998; Yeung, 1999), should be examined in future cognitive load research. This study extends the scope of cognitive load research by relating computer experience to cognitive load. With the increasing implementation of web-based course content in education and training in the United States, the use of hypertext annotations have developed to the extent that various aspects of learning, including students' individual differences, should be further researched in the context of CLT.

Another key finding from this study in terms of learner control was that the embedded annotation presentation format was ranked the lowest among the different presentation formats. Although the other annotation presentation formats did not show significant difference among themselves in terms of learner control, the difference was significant between the embedded format and other formats, that is, the embedded annotation seemed to provide less control or choices to students in accessing annotations. It implies that alternate choices or presentation formats should be provided to students when hypertext annotations are provided. As Deci and Ryan (2000a; b) and Schunk (2004) indicated, learner control over task engagement had critical influence on students' motivation. Furthermore, well-conceived choices or formats for learner



control can enhance learning, performance and persistence (Connell & Wellborn, 1991; deCharms, 1984; Morrison, 2004; Skinner, Wellborn & Connell, 1990; van Merriënboer, Schuurman, de Croock, & Paas, 2002; Vansteenkiste et al, 2004).

Finally, learner control generated by different annotation presentation formats was found to be negatively related to the overall cognitive load in this study, as measured by Yeung, Lee, Pena, and Ryde's (2000) Subjective Mental Workload. The construct of learner control was discussed from various cognitive perspectives. For example, learner control was considered as an important dimension of PBL. As Arts, Gijssels and Segers (2002) put it, the effects of a higher degree of learner control are "intrinsically highly motivated students and more active and autonomous students" (p.471). Likewise, support for learner control seemed to be effective in changing students' view of learning towards more autonomy when Internet was used for searching information in a translation class (Yumuk, 2002). This study revealed the negative relationship between the overall cognitive load or mental workload and learner control as generated by different annotation presentation formats. It implies that an annotation presentation format could be designed in future cognitive load research that might provide significantly higher learner control and reduce the overall cognitive load at the same time. Augmented with the notion of learner control, CLT serves as a better theoretical foundation for the design of hypertext-based instruction (Gerjets & Scheiter, 2003). A previous study conducted by van Merriënboer, Schuurman, de Croock, & Paas (2002) contributed to CLT by examining the germane cognitive load and learner control while Morrison's (2004) study suggested a negative relationship between extraneous cognitive load and learner control. This study however sheds light on the relationship between learner control and the overall cognitive load, using the measurement of Yeung, Lee, Pena, and Ryde's Subjective Mental Workload.

Based on the key findings depicted above, it is suggested that the effectiveness of new technologies such as the different hypertext annotation presentation formats should be further researched. The next step is to use triangulated research design and methods including qualitative methods. Moreover, other variables including individual differences and learners' content familiarity should be considered. Finally, other content areas such as technical software manuals and interactive websites including Wikis and Bloggers should be examined with respect to the use of different hypertext annotations.

## APPENDIX A: THE WEB-BASED TEXT WITHOUT ANNOTATIONS

## Erikson's Eight Stages of Psychosocial Development

Erik Erikson (1902-1994) sees life-span development as a passage through eight stages, each with its particular needs, goals, accomplishments, and dangers. At each stage, Erikson suggests that the individual faces a developmental crisis or challenge that he or she must resolve in a balanced way.

The eight stages that each individual goes through during his or her lifetime are interdependent: "accomplishments at later stages depend on how conflicts are resolved in the earlier years" (Woolfolk, 2004, p. 66). An individual moves from one stage to the next, but he or she is affected by past crises and healthy or unhealthy resolutions. No crisis is permanently settled, but a positive resolution of one psychosocial challenge at its stage increases the likelihood of a positive resolution of the next challenge at the next stage. (Eggen & Kauchak, 2004)

Erikson's eight stages of psychosocial development are depicted as follows.

- **Birth to 1 Year: Trust Versus Mistrust.**

The basic challenge of infancy is trust vs. mistrust. Infants are beginning to learn that they are separate from the world around them and are instinctively motivated to establish a sense of trust in the world. If an infant's needs are met with comforting regularity and responsiveness by the infant's caregiver, then trust is developed. Failure to develop trust in the first year will lead to mistrust of other people (Isabella & Belsky, 1991).

- **Age 1 to 3: Autonomy Versus Shame and Doubt.**

During this period, the challenge is autonomy vs. shame and doubt. Parents must be protective, but not overprotective, so their child can develop a sense of self-sufficiency. Overly restrictive parents or ones who punish children for failures such as potty mistakes and bedwetting can lead children to doubt their own abilities or feel ashamed. Children who experience too much doubt at this stage will lack confidence in their own abilities.

- **Ages 3 to 6: Initiative Versus Guilt.**

The challenge for young children is initiative v. guilt. During this period, children need to develop a sense of self-direction and self-assertion. They must maintain a zest for activity, but at the same time keep in mind that not every impulse can be acted on. They should develop a willingness to try new adventures without putting themselves at serious risk. Parents who criticize or punish initiative cause children to feel guilty about their self-initiated activities.

- **Ages 6 to 12: Industry Versus Inferiority.**

Elementary school children face the challenge of industry v. inferiority. They are beginning to see the relationship between perseverance and the pleasure of a job completed. Industry develops when learners acquire a sense of competence through successes on tasks they consider challenging, not on tasks too hard or too easy for them. A pattern of failure such as difficulty learning to read can lead to feelings of inferiority.

- **Ages 12 to 18- Identity Versus Confusion.**

For adolescents, the main challenge is that of identity v. confusion. According to psychosocial theory, this is the central issue of human development. Adolescents must answer the question, “Who am I?” to provide a firm basis for adulthood. Identity involves making choices and decisions, particularly about work, values, ideology, and commitments to people and ideas (Marcia, 1987; Penuel & Wertsch, 1995). If adolescents fail to make decisions or identify too much with others, role confusion threatens.

- **Young Adulthood- Intimacy Versus Isolation.**

In this stage, young adults deal with the challenge of intimacy v. isolation. Intimacy develops when individuals with a clear sense of identity are able to give themselves over to another. In the American society, this is often seen as commitment to another person in the form of marriage, but it can also mean a commitment to close friends and relatives. People who fail to meet the psychosocial challenge remain emotionally isolated, unable to give and receive love freely.

- **Middle Adulthood- Generativity Versus Stagnation.**

At middle adulthood, the challenge is generativity v. stagnation. Generative adults are committed to guide the next generation and adhere to the principles of freedom and dignity for all people. They feel that they are contributing something of value to their society, such as raising children or performing needed roles in the society. An unhealthy resolution of the psychosocial challenge leads to apathy, or self-absorption.

- **Old Age-Integrity Versus Despair.**

At old age, the challenge is one of integrity v. despair. Integrity occurs when people achieve a sense of self and fully accept its unique and unalterable history. They can look back with contentment on their lives as well-lived. Those unable to attain a feeling of lifetime fulfillment sink into despair.

#### References:

Eggen, P. & Kauchak, D. (2004). Educational psychology: Windows on classrooms. New Jersey: Person Education, Inc.

Isabella, R., & Belsky, J. (1991). Interactional synchrony and the origin of infant-mother attachment: A replication study. *Child Development*, 62, 373-384.

Marcia, J. E. (1987). The identity status approach to the study of ego identity development. In T. Honess &

K. Yardley (Eds.), *Self and identity: Perspective across the life span* (pp. 161-171). London: Routledge & Kegan Paul.

Penuel, W. R., & Wertsch, J. V. (1995). Vygotsky and identity formation: A sociocultural approach. *Educational Psychologist*, 30, 83-92.

Woolfolk, A. (2004). *Educational psychology*. New Jersey: Person Education, Inc.

## APPENDIX B: THE WEB-BASED TEXT WITH EMBEDDED ANNOTATIONS

## Erikson's Eight Stages of Psychosocial Development

Erik Erikson (1902-1994) sees life-span development as a passage through eight stages, each with its particular needs, goals, accomplishments, and dangers. At each stage, Erikson suggests that the individual faces a developmental **crisis** (*a conflict between a positive alternative and a potentially unhealthy alternative*) or challenge that he or she must resolve in a balanced way.

The eight stages that each individual goes through during his or her lifetime are interdependent: "accomplishments at later stages depend on how conflicts are resolved in the earlier years" (Woolfolk, 2004, p. 66). An individual moves from one stage to the next, but he or she is affected by past crises and healthy or unhealthy resolutions. No crisis is permanently settled, but a positive resolution of one **psychosocial** (*the relation of the individual's emotional needs to the social environment*) challenge at its stage increases the likelihood of a positive resolution of the next challenge at the next stage. (Eggen & Kauchak, 2004)

Erikson's eight stages of psychosocial development are depicted as follows.

- **Birth to 1 Year: Trust Versus Mistrust.**

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- **Age 1 to 3: **Autonomy** (*independence*) Versus Shame and Doubt.**

During this period, the challenge is autonomy vs. shame and doubt. Parents must be protective, but not overprotective, so their child can develop a sense of self-sufficiency. Overly restrictive parents or ones who punish children for failures such as potty mistakes and bedwetting can lead children to doubt their own abilities or feel ashamed. Children who experience too much doubt at this stage will lack confidence in their own abilities.

- **Ages 3 to 6: **Initiative** (*willingness to begin new activities and explore new directions*)\_Versus Guilt.**

The challenge for young children is initiative v. guilt. During this period, children need to develop a sense of self-direction and self-assertion. They must maintain a zest for activity, but at the same time keep in mind that not every impulse can be acted on. They should develop a willingness to try new adventures without putting themselves at serious risk. Parents who criticize or punish initiative cause children to feel guilty about their self-initiated activities.



- **Ages 6 to 12: Industry** (*eagerness to engage in productive work*) **Versus Inferiority.**

Elementary school children face the challenge of industry v. inferiority. They are beginning to see the relationship between perseverance and the pleasure of a job completed. Industry develops when learners acquire a sense of competence through successes on tasks they consider challenging, not on tasks too hard or too easy for them. A pattern of failure such as difficulty learning to read can lead to feelings of inferiority.

- **Ages 12 to 18- Identity** (*the organization of the individual's drives, abilities, beliefs, and history into a consistent image of self*) **Versus Confusion.**

For adolescents, the main challenge is that of identity v. confusion. According to psychosocial theory, this is the central issue of human development. Adolescents must answer the question, "Who am I?" to provide a firm basis for adulthood. Identity involves making choices and decisions, particularly about work, values, ideology, and commitments to people and ideas (Marcia, 1987; Penuel & Wertsch, 1995). If adolescents fail to make decisions or identify too much with others, role confusion threatens.

- **Young Adulthood- Intimacy Versus Isolation.**

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- **Middle Adulthood- Generativity** (*sense of concern for future generations*) **Versus Stagnation.**

At middle adulthood, the challenge is generativity v. stagnation. Generative adults are committed to guide the next generation and adhere to the principles of freedom and dignity for all people. They feel that they are contributing something of value to their society, such as raising children or performing needed roles in the society. An unhealthy resolution of the psychosocial challenge leads to apathy, or self-absorption.

- **Old Age-Integrity** (*sense of self-acceptance and fulfillment*) **Versus Despair.**

At old age, the challenge is one of integrity v. despair. Integrity occurs when people achieve a sense of self and fully accept its unique and unalterable history. They can look back with contentment on their lives as well-lived. Those unable to attain a feeling of lifetime fulfillment sink into despair.

#### References:

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Isabella, R., & Belsky, J. (1991). Interactional synchrony and the origin of infant-mother attachment: A

replication study. *Child Development*, 62, 373-384.

Marcia, J. E. (1987). The identity status approach to the study of ego identity development. In T. Honess & K. Yardley (Eds.), *Self and identity: Perspective across the life span* (pp. 161-171). London: Routledge & Kegan Paul.

Penuel, W. R., & Wertsch, J. V. (1995). Vygotsky and identity formation: A sociocultural approach. *Educational Psychologist*, 30, 83-92.

Woolfolk, A. (2004). *Educational psychology*. New Jersey: Person Education, Inc.

APPENDIX C: THE WEB-BASED TEXT WITH MULTIPLE ANNOTATIONS

## Erikson's Eight Stages of Psychosocial Development

Erik Erikson (1902-1994) sees life-span development as a passage through eight stages, each with its particular needs, goals, accomplishments, and dangers. At each stage, Erikson suggests that the individual faces a developmental **crisis** (*a conflict between a positive alternative and a potentially unhealthy alternative*) or challenge that he or she must resolve in a balanced way.

The eight stages that each individual goes through during his or her lifetime are interdependent: "accomplishments at later stages depend on how conflicts are resolved in the earlier years" (Woolfolk, 2004, p. 66). An individual moves from one stage to the next, but he or she is affected by past crises and healthy or unhealthy resolutions. No crisis is permanently settled, but a positive resolution of one **psychosocial** (*the relation of the individual's emotional needs to the social environment*) challenge at its stage increases the likelihood of a positive resolution of the next challenge at the next stage. (Eggen & Kauchak, 2004)

Erikson's eight stages of psychosocial development are depicted as follows.

- **Birth to 1 Year: Trust Versus Mistrust.**

The basic challenge of infancy is trust vs. mistrust. Infants are beginning to learn that they are separate from the world around them and are instinctively motivated to establish a sense of trust in the world. If an infant's needs are met with comforting regularity and responsiveness by the infant's caregiver, then trust is developed. Failure to develop trust in the first year will lead to mistrust of other people (Isabella & Belsky, 1991).

- **Age 1 to 3: **Autonomy** (*independence*) Versus Shame and Doubt.**

During this period, the challenge is autonomy vs. shame and doubt. Parents must be protective, but not overprotective, so their child can develop a sense of self-sufficiency. Overly restrictive parents or ones who punish children for failures such as potty mistakes and bedwetting can lead children to doubt their own abilities or feel ashamed. Children who experience too much doubt at this stage will lack confidence in their own abilities.

- **Ages 3 to 6: **Initiative** (*willingness to begin new activities and explore new directions*)\_Versus Guilt.**

The challenge for young children is initiative v. guilt. During this period, children need to develop a sense of self-direction and self-assertion. They must maintain a zest for activity, but at the same time keep in mind that not every impulse can be acted on. They should develop a willingness to try new adventures without putting themselves at serious risk. Parents who criticize or punish initiative cause children to feel guilty about their self-initiated activities.

- **Ages 6 to 12: Industry** (*eagerness to engage in productive work*) **Versus Inferiority.**

Elementary school children face the challenge of industry v. inferiority. They are beginning to see the relationship between perseverance and the pleasure of a job completed. Industry develops when learners acquire a sense of competence through successes on tasks they consider challenging, not on tasks too hard or too easy for them. A pattern of failure such as difficulty learning to read can lead to feelings of inferiority.

- **Ages 12 to 18- Identity** (*the organization of the individual's drives, abilities, beliefs, and history into a consistent image of self*) **Versus Confusion.**

For adolescents, the main challenge is that of identity v. confusion. According to psychosocial theory, this is the central issue of human development. Adolescents must answer the question, "Who am I?" to provide a firm basis for adulthood. Identity involves making choices and decisions, particularly about work, values, ideology, and commitments to people and ideas (Marcia, 1987; Penuel & Wertsch, 1995). If adolescents fail to make decisions or identify too much with others, role confusion threatens.

- **Young Adulthood- Intimacy Versus Isolation.**

In this stage, young adults deal with the challenge of intimacy v. isolation. Intimacy develops when individuals with a clear sense of identity are able to give themselves over to another. In the American society, this is often seen as commitment to another person in the form of marriage, but it can also mean a commitment to close friends and relatives. People who fail to meet the psychosocial challenge remain emotionally isolated, unable to give and receive love freely.

- **Middle Adulthood- Generativity** (*sense of concern for future generations*) **Versus Stagnation.**

At middle adulthood, the challenge is generativity v. stagnation. Generative adults are committed to guide the next generation and adhere to the principles of freedom and dignity for all people. They feel that they are contributing something of value to their society, such as raising children or performing needed roles in the society. An unhealthy resolution of the psychosocial challenge leads to apathy, or self-absorption.

- **Old Age-Integrity** (*sense of self-acceptance and fulfillment*) **Versus Despair.**

At old age, the challenge is one of integrity v. despair. Integrity occurs when people achieve a sense of self and fully accept its unique and unalterable history. They can look back with contentment on their lives as well-lived. Those unable to attain a feeling of lifetime fulfillment sink into despair.

[Online Glossary](#)

References:

Eggen, P. & Kauchak, D. (2004). *Educational psychology: Windows on classrooms*. New Jersey: Person

Education, Inc.

Isabella, R., & Belsky, J. (1991). Interactional synchrony and the origin of infant-mother attachment: A replication study. *Child Development*, 62, 373-384.

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APPENDIX D: THE WEB-BASED TEXT WITH ONLINE GLOSSARY  
ANNOTATIONS

## Erikson's Eight Stages of Psychosocial Development

Erik Erikson (1902-1994) sees life-span development as a passage through eight stages, each with its particular needs, goals, accomplishments, and dangers. At each stage, Erikson suggests that the individual faces a developmental **crisis** or challenge that he or she must resolve in a balanced way.

The eight stages that each individual goes through during his or her lifetime are interdependent: "accomplishments at later stages depend on how conflicts are resolved in the earlier years" (Woolfolk, 2004, p. 66). An individual moves from one stage to the next, but he or she is affected by past crises and healthy or unhealthy resolutions. No crisis is permanently settled, but a positive resolution of one **psychosocial** challenge at its stage increases the likelihood of a positive resolution of the next challenge at the next stage. (Eggen & Kauchak, 2004)

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- **Age 1 to 3: **Autonomy** Versus Shame and Doubt.**

During this period, the challenge is autonomy vs. shame and doubt. Parents must be protective, but not overprotective, so their child can develop a sense of self-sufficiency. Overly restrictive parents or ones who punish children for failures such as potty mistakes and bedwetting can lead children to doubt their own abilities or feel ashamed. Children who experience too much doubt at this stage will lack confidence in their own abilities.

- **Ages 3 to 6: **Initiative** Versus Guilt.**

The challenge for young children is initiative v. guilt. During this period, children need to develop a sense of self-direction and self-assertion. They must maintain a zest for activity, but at the same time keep in mind that not every impulse can be acted on. They should develop a willingness to try new adventures without putting themselves at serious risk. Parents who criticize or punish initiative cause children to feel guilty about their self-initiated activities.

- **Ages 6 to 12: **Industry** Versus Inferiority.**

Elementary school children face the challenge of industry v. inferiority. They are beginning to see the relationship between perseverance and the pleasure of a job completed. Industry develops when learners



acquire a sense of competence through successes on tasks they consider challenging, not on tasks too hard or too easy for them. A pattern of failure such as difficulty learning to read can lead to feelings of inferiority.

- **Ages 12 to 18- Identity Versus Confusion.**

For adolescents, the main challenge is that of identity v. confusion. According to psychosocial theory, this is the central issue of human development. Adolescents must answer the question, “Who am I?” to provide a firm basis for adulthood. Identity involves making choices and decisions, particularly about work, values, ideology, and commitments to people and ideas (Marcia, 1987; Penuel & Wertsch, 1995). If adolescents fail to make decisions or identify too much with others, role confusion threatens.

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- **Middle Adulthood- Generativity Versus Stagnation.**

At middle adulthood, the challenge is generativity v. stagnation. Generative adults are committed to guide the next generation and adhere to the principles of freedom and dignity for all people. They feel that they are contributing something of value to their society, such as raising children or performing needed roles in the society. An unhealthy resolution of the psychosocial challenge leads to apathy, or self-absorption.

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## APPENDIX E: THE WEB-BASED TEXT WITH ROLL-OVER ANNOTATIONS

## Erikson's Eight Stages of Psychosocial Development

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## APPENDIX F: LEARNER SURVEY (FOR CONTROL GROUP)

# Learner Survey

REQUIRED: Group ID (from the Instruction sheet)  Student Name

## Part I: Perceptions

Following are statements relating to your reading about Erikson's theory. Please indicate your response to each statement.

		<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neither</u>	<u>Agree</u>	<u>Strongly Agree</u>
1	I was very interested in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Reading the text was too hard for me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	When I read the text, I came across new terms.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	I like this kind of reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	I did the reading too badly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	I'd prefer to be provided with explanations for new terms in my reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	I had no difficulty in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	I mind doing similar reading again.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	I understood what I read.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	I was already familiar with the content when I read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	The content of the text is worth knowing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



12	I worked hard to read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	I did the reading very well.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Neither</u>	<u>Agree</u>	<u>Strongly Agree</u>
14	The content of the text is relevant to my interests.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	I hate doing the same activity again.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	I paid attention throughout the reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	I had much difficulty in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	I did the reading seriously.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	My reading was badly affected by my technical errors with the use of computer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	I tried to get everything understood during the reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21	The content of the text was new to me when I read it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	I had no trouble using the computer to read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	I didn't understand what I read.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	I could relate Erikson's theory to things I have seen, done, or thought about in my own life.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	Reading the text was easy enough.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	The content of this text will be useful to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Part II: Demographics**

**27. Gender**

Male  Female

**28. Age**

18-25  26-35  36-45  46-55  56-65  66+

**29. Year in school**

Freshman  Sophomore  Junior  Senior  Other

**30. Race/Ethnicity**

Asian/Pacific Islander  Black/African American (not Hispanic)

Caucasian/White (not Hispanic)

Hispanic/Latinos/Chicano  Native American/American Indian  Other

## APPENDIX G: LEARNER SURVEY (FOR TREATMENT GROUPS)

# Learner Survey

REQUIRED: Group ID (from the Instruction sheet)  Student Name

## Part I: Perceptions

Following are statements relating to your reading about Erikson's theory. Please indicate your response to each statement.

		<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Neither</i>	<i>Agree</i>	<i>Strongly Agree</i>
1	I was very interested in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Reading the text was too hard for me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	I had control over what explanations to access and read for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	I like this kind of reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	I did the reading too badly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	I had choices over how to access and read explanations for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	I had no difficulty in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	I mind doing similar reading again.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	I understood what I read.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	I was already familiar with the content when I read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	It was up to me when to access and read explanations for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	I worked hard to read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	I did the reading very well.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<i>Strongly Disagree</i>	<i>Disagree</i>	<i>Neither</i>	<i>Agree</i>	<i>Strongly Agree</i>
14	I had no control over what explanations to access and read for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	I hate doing the same activity again.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16	I paid attention throughout the reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	I had much difficulty in reading the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	I did the reading seriously.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	My reading was badly affected by my technical errors with the use of computer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	I tried to get everything understood during the reading.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21	The content of the text was new to me when I read it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	I had serious trouble using the computer to read the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	I didn't understand what I read.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	I had no choice over how to access and read explanations for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	Reading the text was easy enough.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	I didn't have a choice over when to access and read explanations for new terms in the text.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Part II: Demographics

### 27. Gender

Male  Female

### 28. Age

18-25  26-35  36-45  46-55  56-65  66+

### 29. Year in school

Freshman  Sophomore  Junior  Senior  Other

### 30. Race/Ethnicity

Asian/Pacific Islander  Black/African American (not Hispanic)

Caucasian/White (not Hispanic)

Hispanic/Latinos/Chicano  Native American/American Indian  Other

Submit

## APPENDIX H: LEARNING QUIZ

## Quiz

REQUIRED: Group ID (from the Instruction sheet)  Student Name

**Directions:** Please answer each question on your own & **DO NOT** use any references, including the text that you've just read.

### A. Matching Terms with Explanations

1. Autonomy	<input type="text" value="Select..."/>
2. Crisis	<input type="text" value="Select..."/>
3. Generativity	<input type="text" value="Select..."/>
4. Identity	<input type="text" value="Select..."/>
5. Industry	<input type="text" value="Select..."/>
6. Initiative	<input type="text" value="Select..."/>
7. Integrity	<input type="text" value="Select..."/>
8. Psychosocial	<input type="text" value="Select..."/>

*Select the correct explanation.*

### B. Multiple Choice

*Select the correct answer.*

9. Erikson's stage theory is mainly concerned with:

- behaviors and their consequences
- the development of moral values
- the formation of a personal identity
- the process of acculturation in school settings

10. Erikson's lifespan theory involves all of the following influences **except:**



- biological from heredity and environmental influences
- economic from family status and personal lifestyle
- social from family, peers, and other people
- psychological from mental and emotional processing by the individual

11. According to Erikson, if a child doesn't resolve a stage's crisis in a healthy way, the child is

apt to:

- encounter problems with resolutions of later crises.
- forget the crisis and progress normally.
- remain at the unresolved stage until the crisis is resolved.
- resolve the crisis at a later stage.

12. Which one of the following is not a positive alternative to resolve the Industry versus Inferiority conflict?

- developing interaction with peer
- balancing school work and neighborhood activities
- postponing homework
- correcting mistakes

13. According to Erikson, which of the following crisis or challenges is the central issue of human development?

- Industry versus Inferiority

Identity versus Confusion

Trust versus Mistrust

Autonomy versus Shame and Doubt

14. Parents of young children have to deal with Initiative versus Guilt developmental conflicts,

including which one of the following?

smiling for the caregiver versus night crying

exploring alone versus clinging to adult

using the toilet alone versus wetting pants

acting out stories versus embarrassment to play a role

15. Third grader Jennifer is afraid to try new seatwork by herself. She claims that the work is too

hard and she waits until the teacher or aide can help her. According to Erikson, Jennifer is

being challenged and not succeeding at what level?

Autonomy versus Shame and Doubt

Industry versus Inferiority

Trust versus Mistrust

Initiative versus Guilt

16. In middle school, which one of these choices would be **least** likely to be part of Identity versus Confusion?

work & career

- religious values
- close friendships
- personal income

**C. True/False**

17. On the playground, preschoolers who are not finding a balanced resolution at their stage

might either act too daringly or too shy and withdrawn.

- True
- False

18. To help toddlers become independent, parents should potty train them very early.

- True
- False

19. In Erikson's theory, an individual faces a specific conflict or crisis at each stage of life that

needs to be resolved or he or she will not move beyond that stage.

- True
- False

20. Adolescents might overly identify with a peer group or a clique and not develop fully an individual identity.

- True
- False

21. According to Erikson's theory, elementary students who are struggling in school need to be

given very easy tasks that don't push or challenge them.

True

False

22. For adults, the contribution to society is not as important as the individual's perspective about

his or her contribution.

True

False

APPENDIX I: INSTRUCTION SHEET (FOR EMBEDDED GROUP)

**Group ID:** \_\_\_\_\_

*Please complete the following 5 tasks one by one. Thank you!*

1. Double click Internet Explorer on your desktop, key in <http://pegasus.cc.ucf.edu/~yyao/ic.htm>, & complete the *form (online submission)* within 2 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

2. Key in <http://pegasus.cc.ucf.edu/~yyao/training-ea.htm>, & complete the *brief training* within 3 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

3. Key in <http://pegasus.cc.ucf.edu/~yyao/ea.htm>, & read the *text* for 10 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

4. Key in <http://pegasus.cc.ucf.edu/~yyao/survey.htm>, & finish the *survey* within 10 minutes (**online submission**).

**CLOSE** the window, **STOP & Wait** for further instructions.

5. Key in <http://pegasus.cc.ucf.edu/~yyao/quiz.htm>, & finish the *quiz* within 15 minutes (**online submission**).

**CLOSE** the window, & **shut down** your computer.

APPENDIX J: INSTRUCTION SHEET (FOR MULTIPLE ANNOTATIONS  
GROUP)

**Group ID:** \_\_\_\_\_

*Please complete the following 5 tasks one by one. Thank you!*

6. Double click Internet Explorer on your desktop, key in <http://pegasus.cc.ucf.edu/~yyao/ic.htm>, & complete the *form (online submission)* within 2 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

7. Key in <http://pegasus.cc.ucf.edu/~yyao/training-ma.htm>, & complete the *brief training* within 3 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

8. Key in <http://pegasus.cc.ucf.edu/~yyao/ma.htm>, & read the *text* for 10 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

9. Key in <http://pegasus.cc.ucf.edu/~yyao/survey.htm>, & finish the *survey* within 10 minutes (**online submission**).

**CLOSE** the window, **STOP & Wait** for further instructions.

10. Key in <http://pegasus.cc.ucf.edu/~yyao/quiz.htm>, & finish the *quiz* within 15 minutes (**online submission**).

**CLOSE** the window, & **shut down** your computer.



APPENDIX K: INSTRUCTION SHEET (FOR NO ANNOTATIONS GROUP)

**Group ID:** \_\_\_\_\_

*Please complete the following 5 tasks one by one. Thank you!*

11. Double click Internet Explorer on your desktop, key in <http://pegasus.cc.ucf.edu/~yyao/ic.htm>, & complete the *form* (**online submission**) within 2 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

12. Key in <http://pegasus.cc.ucf.edu/~yyao/training-na.htm>, & complete the *brief training* within 3 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

13. Key in <http://pegasus.cc.ucf.edu/~yyao/na.htm>, & read the *text* for 10 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

14. Key in <http://pegasus.cc.ucf.edu/~yyao/survey-na.htm>, & finish the *survey* within 10 minutes (**online submission**).

**CLOSE** the window, **STOP & Wait** for further instructions.

15. Key in <http://pegasus.cc.ucf.edu/~yyao/quiz.htm>, & finish the *quiz* within 15 minutes (**online submission**).

**CLOSE** the window, & **shut down** your computer.

APPENDIX L: INSTRUCTION SHEET (FOR ONLINE GLOSSARY GROUP)

**Group ID:** \_\_\_\_\_

*Please complete the following 5 tasks one by one. Thank you!*

1. Double click Internet Explorer on your desktop, key in <http://pegasus.cc.ucf.edu/~yyao/ic.htm>, & complete the *form (online submission)* within 2 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

2. Key in <http://pegasus.cc.ucf.edu/~yyao/training-og.htm>, & complete the *brief training* within 3 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

3. Key in <http://pegasus.cc.ucf.edu/~yyao/og.htm>, & read the *text* for 10 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

4. Key in <http://pegasus.cc.ucf.edu/~yyao/survey.htm>, & finish the *survey* within 10 minutes (**online submission**).

**CLOSE** the window, **STOP & Wait** for further instructions.

5. Key in <http://pegasus.cc.ucf.edu/~yyao/quiz.htm>, & finish the *quiz* within 15 minutes (**online submission**).

**CLOSE** the window, & **shut down** your computer.

APPENDIX M: INSTRUCTION SHEET (FOR ROLL-OVER ANNOTATIONS  
GROUP)

**Group ID:** \_\_\_\_\_

*Please complete the following 5 tasks one by one. Thank you!*

6. Double click Internet Explorer on your desktop, key in <http://pegasus.cc.ucf.edu/~yyao/ic.htm>, & complete the *form (online submission)* within 2 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

7. Key in <http://pegasus.cc.ucf.edu/~yyao/training-ra.htm>, & complete the *brief training* within 3 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

8. Key in <http://pegasus.cc.ucf.edu/~yyao/ra.htm>, & read the *text* for 10 minutes.

**CLOSE** the window, **STOP & Wait** for further instructions.

9. Key in <http://pegasus.cc.ucf.edu/~yyao/survey.htm>, & finish the *survey* within 10 minutes (**online submission**).

**CLOSE** the window, **STOP & Wait** for further instructions.

10. Key in <http://pegasus.cc.ucf.edu/~yyao/quiz.htm>, & finish the *quiz* within 15 minutes (**online submission**).

**CLOSE** the window, & **shut down** your computer.

## APPENDIX N: TRAINING (FOR EMBEDDED GROUP)

## Training

You'll read a short text (about 800 words) in 10 minutes and do a quiz (22 multiple choice & True/ false questions). This brief training describes how explanations are provided following certain **terms** in the text that you'll read.

Please note that the terms are highlighted while the explanations are italicized & put in brackets.

**Example:** A typical UCF account is separated into two types of web pages: **Reach** (*the UCF server that houses each online or enhanced course*) and **WebCT** (*a tool for the creation of web-based learning environments*).



## APPENDIX O: TRAINING (FOR MULTIPLE ANNOTATIONS GROUP)

## Training

You'll read a short text (about 800 words) in 10 minutes and do a quiz (22 multiple choice & True/ false questions). This brief training describes how explanations are provided for certain **terms** in the text that you'll read.

Please note that the terms are highlighted while the explanations are italicized & put in brackets. Also, you can move your mouse over the highlighted terms to reveal the explanations. Finally, you can go to the bottom of the text and double click the online glossary to get the explanations.

**Example:** A typical UCF account is separated into two types of web pages, [Reach](#) (*the UCF server that houses each online or enhanced course*) and [WebCT](#) (*a tool for the creation of web-based learning environments*).

[Online Glossary](#)

## APPENDIX P: TRAINING (FOR NO ANNOTATIONS GROUP)

## **Training**

You'll read a short text (about 800 words) in 10 minutes and do a quiz (22 multiple choice & True/ false questions). Please note that no more training is considered necessary here.

APPENDIX Q: TRAINING (FOR ONLINE GLOSSARY ANNOTATIONS  
GROUP)

## Training

You'll read a short text (about 800 words) in 10 minutes and do a quiz (22 multiple choice & True/ false questions). This brief training describes how explanations are provided for certain [terms](#) in the text that you'll read.

Please note that you can go to the bottom of the text and double click the online glossary to get explanations for terms.

**Example:** A typical UCF account is separated into two types of web pages, [Reach](#) and [WebCT](#).

[Online Glossary](#)

## APPENDIX R: TRAINING (FOR ROLL-OVER ANNOTATIONS GROUP)

## Training

You'll read a short text (about 800 words) in 10 minutes and do a quiz (22 multiple choice & True/ false questions). This brief training describes how explanations are provided for certain [terms](#) in the text that you'll read.

Please note that you can move your mouse over the highlighted terms to reveal the hidden explanations for them.

**Example:** A typical UCF account is separated into two types of web pages: [Reach](#) and [WebCT](#).



## APPENDIX S: INFORMED CONSENT FORM

## Informed Consent

**Please read this consent document carefully before you decide to participate in this study.**

Project title: "The Effect of Different Presentation Formats of Hypertext Annotations on Cognitive Load and Learning"

Purpose of the research study: to investigate the effect of hypertext annotation presentation formats on cognitive load and learning.

What you will be asked to do in the study: During class, you will be asked to read a text related to educational psychology. After reading, you will be asked to finish a survey and a quiz.

Time required: 40 minutes

Risks: There are no anticipated risks to participating in this study.

Benefits / Compensation: You will receive no or 3-5 extra credit points for participation in this research based on your instructor's grading scheme. This research activity will be required as part of the class activity if no extra credits are given in your class.

Confidentiality: Your identity will be kept confidential. Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report.

Voluntary participation: Your participation in this study is voluntary. There is no penalty for not participating.

Right to withdraw from the study: You have the right to withdraw from the study at any time without consequence.

Whom to contact if you have questions about the study: Yuanming Yao, Ph.D. Candidate, Department of Educational Research, Technology, and Leadership, Address, 12009 Solon Dr. Apt. 209, Orlando, FL 32816 Office Phone: 407/823-4830 E-mail: yyao@mail.ucf.edu or Dr.

Gary Orwig, Faculty Supervisor, College of Education, The telephone number is: (407) 823-5179

Whom to contact about your rights in the study: UCFIRB Office, University of Central Florida Office of Research, Orlando Tech Center, 12443 Research Parkway, Suite 302, Orlando, FL 32826. The phone number is (407) 823-2901.

1. This study requires participants to be at least 18 years, so please

2. I have read the procedure described above and I voluntarily agree to participate in the procedure (key in your full name here)

3. Date of Participation (mm/dd/yy)

Signatures of Principal and Co-Principal Investigator: GaryOrwig, YuanmingYao

Submit

APPENDIX T: IRB APPROVAL LETTER



Office of Research & Commercialization

November 7, 2005

Yuanming Yao  
12009 Solon Dr.  
University Apartments #209  
Orlando, FL 32826

Dear Mr. Yao:

With reference to your protocol #05-3045 entitled, "**Effect of Different Presentation Formats of Hypertext Annotations on Cognitive Load, Satisfaction, and Cognitive Learning Outcomes,**" I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 11/4/05 and the expiration date will be 11/03/06.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. **Please notify the IRB office when you have completed this research study.**

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

*Barbara Ward*

Barbara Ward, CIM  
UCF IRB Coordinator  
(FWA00000351, IRB00001138)

Copies: IRB File  
Gary Orwig, Ph.D.

Figure 4 : UCF IRB Approval Letter

APPENDIX U: REPRINT PERMISSIONS FOR FIGURE 1 AND 2

3000 Levy Road Learning Systems Institute  
Florida State University  
Tallahassee, FL 32310  
UNITED STATES

May 9, 2006

Ms. Rosita Sturm  
Springer  
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Tiergartenstrasse 17  
69121 Heidelberg

Dear Ms. Rosita Sturm:

I am completing a doctoral dissertation at University of Central Florida entitled "The Effect of Different Presentation Formats of Hypertext Annotations on Cognitive Load, Learner Control and Learning". I would like your permission to reprint in my dissertation excerpts from the following:

Sweller, J., van Merriënboer, J. J. G. & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10(3), 251-296.

The excerpts to be reproduced are: Figure 2: Example demonstrating split attention & Figure 3: Integrated example with no split attention.

The requested permission extends to any future revisions and editions of my dissertation, including non-exclusive world rights in all languages, and to the prospective publication of my dissertation by UMI. These rights will in no way restrict republication of the material in any other form by you or by others authorized by you. Your signing of this letter will also confirm that you own (or your company owns) the copyright to the above-described material.

If these arrangements meet with your approval, please sign this letter where indicated below and return it to me in the enclosed return envelope. Thank you very much.

Sincerely,

Yuanming Yao (Ms.)

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*May 16, 2006*  
*R. Sturm*

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Figure 5: Reprint Permissions for Figure 1 and Figure 2

---

From: John Sweller <j.sweller@unsw.edu.au>

To: Yuanming Yao

Date: Monday - May 1, 2006

Subject: Re: an urgent request for permission

---

Dear Yuanming

You have permission to use the figures.

All the best

John Sweller

At 9:41 PM -0400 1/5/2006, Yuanming Yao wrote:

>Dear Dr. Sweller,

>

>I used two figures from one of your published papers as cited below for

>my dissertation literature review related to cognitive load theory:



>

>Sweller, J., van Merriënboer, J. J. G. & Paas, F. G. W. C. (1998).

>Cognitive architecture and instructional design. Educational Psychology

>Review, 10(3), 251-296.

>

>Attached please see a Microsoft Word file with the two figures that I

>used in my review of literature that my dissertation committee wanted

>your permission before they can sign on my defense approval form. Would

>you please let me know if I can use them in my literature review of my

>dissertation?

>

>Thanks very much,

>Yuanming "Betty" Yao

>

>Instructional Designer

>Learning Systems Institute

>Florida State University, USA

>phone: 1-850-645-7316(o)

>

>Attachment converted: Mac OS:figures-Sweller.doc (WDBN/«IC») (00217A3C)

APPENDIX V: REPRINT PERMISSIONS FOR FIGURE 3

---

From: Graham Cooper <gcooper@scu.edu.au>

To: Yuanming Yao

Date: Tuesday - May 2, 2006

Subject: Re: request for permission

---

Permission granted. Good luck with your studies.

regards

g

At 12:05 AM 3/05/2006, you wrote:

>Dear Dr. Cooper,

>

>I want to use one figure from your website as cited below for my

>dissertation literature review related to cognitive load theory:

>

>Cooper, G. (1998). Research into cognitive load theory and instructional

>design at UNSW. Retrieved April 30, 2005 from

>[http://education.arts.unsw.edu.au/CLT\\_NET\\_Aug\\_97.HTML](http://education.arts.unsw.edu.au/CLT_NET_Aug_97.HTML).

>

>Attached please see a Microsoft Word file with the figure. Would you

>please let me know if I can use it in my dissertation?

>

>Thanks very much,

>Yuanming "Betty" Yao

>

>Instructional Designer

>Learning Systems Institute

>Florida State University, USA

>phone: 1-850-645-7316(o)

>

Dr Graham Cooper

Course Coordinator, Bachelor of Multimedia

School of Multimedia and Information Technology

Coffs Harbour Education Campus

Southern Cross University

## LIST OF REFERENCES

- Allen, I. E. & Seaman, J. (2004). *Entering the mainstream: The quality and extent of online education in the United States, 2003 and 2004*. Sloan-Consortium.
- Anderson, J. R. (2000). *Cognitive psychology and its implications* (5<sup>th</sup> ed.). New York: Worth Publishers.
- Anderman, L. H., & Midgley, C. (1997). Motivation and middle school students. In Judith L. Irvin. (Ed.). *What current research says to the middle level practitioner?* (pp.1-48). Columbus, OH: National Middle School Association.
- Arant, M.P., Coleman, A.M., & Daniel, B.V. (November, 2002). *Instructional strategies for online courses*. Paper presented at Annual Meeting of Mid-South Educational Research Association.
- Ariew, R. & Ercetin, G. (2004). Exploring the potential of hypermedia annotations for second language reading. *Computer Assisted Language Learning*, 17(2), 237-259.
- Arts, J. A. R., Gijssels, W. H., & Segers, M. S. R. (2002). Cognitive effects of an authentic computer-supported, problem-based learning environment, *Instructional Science*, 30, 465–495.
- Asim, S. & Ercetin, G. (2005). Effectiveness of hypermedia annotations for foreign language reading. *Journal of Computer Assisted Learning*, 21(1), 28-38.
- Aweiss, S. (November, 1993). *The effects of computer-mediated reading supports on the reading comprehension and the reading behavior of beginning American readers of Arabic as a foreign language*. Paper presented at the Annual Meeting of the American Council on the Teaching of Foreign Languages.

- Becker, D. A., & Dwyer, D. A. (1994). Using hypermedia to provide learner control. *Journal of Educational Multimedia and Hypermedia*, 3(2), 155-172.
- Bender, W. N. (1995). *Learning Disabilities: Characteristics, identification, and teaching strategies* (2nd Ed.). Needham Heights, Ma: Allyn & Bacon.
- Brunken, R., Plass, J. L., & Leutner, D. (2003). Direct measurement of cognitive load in multimedia learning. *Educational Psychology*, 38(1), 53-61.
- Brunken, R., Steinbacher, S., Plass, J. L., & Leutner, D. (2002). Assessment of cognitive load in multimedia learning, using dual-task methodology. *Experimental Psychology*, 49(2), 109-119.
- Campbell, D. T., & Stanley, J.C. (1963). *Experimental and quasi-experimental designs for research*. Boston, MA: Houghton Mifflin.
- Chandler, P. and Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction*, 8, 293-332.
- Chandler, P., & Sweller, J. (1996). Cognitive load while learning to use a computer program. *Applied Cognitive Psychology*, 10, 151-170.
- Chou, S. & Liu, C. (2005). Learning effectiveness in a Web-based virtual learning environment: a learner control perspective. *Journal of Computer Assisted Learning*, 21, 65–76.
- Chun, D. M., & Plass, J. L. (1996). Effects of multimedia annotations on vocabulary acquisition. *Modern Language Journal*, 80, 183-198.
- Connell, J., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In M. Gunnar & L. A. Sroufe (Eds.), *Self-processes and development. The Minnesota Symposia on Child Psychology* (pp. 43-77). Hillsdale, NJ: Erlbaum.

Cooper, G. (1998). Research into cognitive load theory and instructional design at UNSW.

Retrieved Nov. 30, 2005 from

[http://education.arts.unsw.edu.au/CLT\\_NET\\_Aug\\_97.HTML](http://education.arts.unsw.edu.au/CLT_NET_Aug_97.HTML).

Darabi, A. & Nelson, D. W. (October, 2004) *Training and transfer of complex cognitive skills:*

*Effects of worked examples and conventional problem-solving.* Paper presented at the

2004 Association for Educational Communications and Technology Convention.

Chicago, IL.

Davis, J.N. (1989). Facilitating effects of marginal glosses on foreign language reading. *The*

*Modern Language Reading*, 73, 41-52.

Davis, J.N. & Lyman-Hager, M. (1997). Computers and L2 reading: student performance,

student abilities. *Foreign Language Annals*, 30, 58-72.

de Charms, R. (1968). *Personal Causation: The internal affective determinants of behavior.* New

York: Academic Press.

de Charms, R. (1984). Motivation enhancement in educational settings. In R. Ames & C. Ames

(Eds.), *Research on motivation in education* (Vol.1, pp. 275-310). Orlando: Academic

Press.

de Croock, M. B. M., van Merriënboer, J. J. G. & Paas, F.G. W. C. (1998). High versus low

contextual interference in simulation-based training of troubleshooting skills: Effects on

transfer performance and invested mental effort. *Computers in Human Behavior*, 14(2),

249-267.

don Sushikar, P. (2001). *A meta-analytic review of factors that influence the effectiveness of*

*Web-based training within the context of distance learning* (Ph.D. dissertation, Texas

- A&M University, United States -- Texas). Retrieved Oct.30 2005, from ProQuest Digital Dissertations database. (Publication No. AAT 3011777).
- Eggen, P. & Kauchak, D. (2004). *Educational psychology: Windows on classrooms*. New Jersey: Person Education.
- Findley, M.J. & Cooper H.M., (1983). Locus of control and academic achievement: A literature review. *Journal of Personality and Social Psychology*, 44(2), 419-427.
- Glass, B. (2004). Comparing representations and reasoning in children and adolescents with two-year college students. *Journal of Mathematical Behavior*, 23(4), 429-442.
- Glass, D. C., & Singer, J. E. (1972). *Urban stress: Experiments on noise and social stressors*. New York: Academic Press.
- Gerjets, P. & Scheiter, K. (2003). Goal configurations and processing strategies as moderators between instructional design and cognitive load: Evidence from hypertext-based instruction. *Educational Psychologist*, 38(1), 33-41.
- Hamilton, H. S. (2004). *The effect of different types of image annotations in a scientific text on different learning outcomes in multimedia learning environments* (Ph.D. dissertation, New York University, United States – New York). Retrieved Oct.30 2005, from ProQuest Digital Dissertations database. (Publication No. AAT 3100791).
- Harris, R., Bolander, K., Lebrun, M., Docq, F., & Bouvy, M. (April, 2004). *Linking perceptions of control and signs of engagement in the process and content of collaborative E-learning*. Paper presented at the Networked Learning 2004 Conference. England, UK.
- Hill, M., & Laufer, B. (2003). Type of task, time-on-task and electronic dictionaries in incidental vocabulary acquisition. *International Review of Applied Linguistics in Language Teaching*, 41(2), 87-106.



- Hsiao, D. (August, 2002). *A cross-cultural study on autonomy and perceived control in learning*.  
Paper presented at the Annual Meeting of the American Psychological Association.
- Jacobs, G. M., Dufong, P., & Hong, F.C. (1994). L1 and L2 vocabulary glosses in L2 reading passages: Their effectiveness for increasing comprehension and vocabulary knowledge. *Journal of Research in Reading*, 17(1), 19-28.
- Jones, L. C. & Plass, J. L. (2002). Supporting listening comprehension and vocabulary acquisition in French with multimedia annotations. *Modern Language Journal*, 86(4), 546-561.
- Kalyuga, S., Chandler, P. & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. *Applied Cognitive Psychology*, 13, 351-371.
- Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist*, 38(1), 23-31.
- Kintsch, W. (1986). Learning from text. *Cognition and Instruction*, 3(2), 87-108.
- Kinzie, Sullivan, & Berdel, M. B., Sullivan, H. J., & Berdel, R. L. (1988). Learner control and achievement in Science Computer-Assisted instruction. *Journal of Educational Psychology*, 80, 299-303.
- Knight S. (1994) Dictionary use while reading: the effects on comprehension and vocabulary acquisition for students of different verbal abilities. *The Modern Language Journal*, 78, 285–299.
- Kubiszyn, T. & Borich, G. (2003). *Educational testing and measurement: Classroom application and practice* (7th Ed.). NY: J. Wiley & Sons.

- Leahy, W., Chandler, P., & Sweller, J. (2003). When auditory presentations should and should not be a component of multimedia instruction. *Applied Cognitive Psychology*, 17, 401-418.
- Le Bohec, O. (2005). Les effets de redondance dans l'apprentissage à partir de documents multimédia. Redundancy effects and the multimedia learning process. *Travail Humain*, 68(2), 97-124.
- Lee, J. K., & Calandra, B. (2004). Can embedded annotations help high school students perform problem solving tasks using a web-based historical document? *Journal of Research on Technology in Education*, 37(1), 65-84.
- Linn, R. L., & Gronlund, N. E. (2005). *Measurement and assessment in teaching* (9th Ed.). Upper Saddle River, NJ: Prentice Hall.
- Lomicka, L. L. (1998). "To Gloss or Not to Gloss": An investigation of reading comprehension online. *Language Learning & Technology*. 1(2). 41-50.
- Maehr, M. L. (1984). Meaning and motivation: toward a theory of personal investment. In R. Ames & C. Ames (Eds.), *Research on motivation in education* (Vol. 1, pp. 115-144). New York: Academic Press.
- Moore, J.C. (2004). *Elements of quality online education: Into the mainstream: Wisdom from the Sloan-Consortium*. Sloan-Consortium.
- Moreland, J. L., Dansereau, D. F. & Chmielewski, T. L. (1997). Recall of descriptive information: The roles of presentation format, annotation strategy, and individual differences. *Contemporary Educational Psychology*, 22(4), 521-533.
- Morrison, G. R., & Anglin, G. J. (2005). Research on cognitive load theory: Application to e-learning. *ETR&D*, 53(3), 94-104.

- Morrison, J. T. (2004). *Reducing the cognitive load presented by definition presentation in electronic learning environments through the use of hypermedia rollovers* (Ph.D. dissertation, University of Central Florida, United States -- Florida). Retrieved Oct.30 2005, from ProQuest Digital Dissertations database. (Publication No. AAT 3134684).
- Niederhauser, D. S., Reynolds, R. E., Salmen, D. J., & Skolmoski, P. (2000). The influences of cognitive load on learning from hypertext. *Journal of Educational Computing*, 23, 237-255
- Nitko, A. J. (2004). *Educational assessment of students* (4th Ed.). Upper Saddle River, NJ: Merrill Prentice Hall.
- Paas, F. G. W.C. (1992). Training strategies for attaining transfer of problem-solving skill in statistics: A cognitive-load approach. *Journal of Educational Psychology*, 84, 429–434.
- Paas, F.G. W. C., van Merriënboer, J.J. G., & Adam, J. J. (1994). Measurement of cognitive load in instructional research. *Percept & Motor Skills*, 79(1), 419-430.
- Paas, F. G. W. C. and van Merriënboer, J. J.G. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review*, 6, 351-371.
- Paas, F.G. W. C., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, 38(1), 1-4.
- Paas, F. G. W. C., Tuovinen, J. E., Tabbers, H., & van Gerven, P. W. M. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist*, 38(1), 63–71.
- Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, Calif.: Sage Publications.

- Plass, J. L., Chun, D. M., Mayer, R. E., & Leutner, D. (1998). Supporting visual and verbal learning preferences in a second-language multimedia learning environment. *Journal of Educational Psychology, 90*(1), 25-36.
- Plass, J. L., Chun, D.M., Mayer, R.E., & Leutner, D. (2003). Cognitive load in reading a foreign language text with multimedia aids and the influence of verbal and spatial abilities. *Computers in Human Behavior, 19*(2), 221-244.
- Rotter, J.B. (1954). *Social Learning and Clinical Psychology*. Englewood Cliffs, NJ: Prentice Hall.
- Rotter, J.B., (1966). Generalized expectancies for internal versus external locus of control of reinforcement. *Psychological Monographs, 80*, 1-28.
- Ryan, R. M. and Deci, E. L. (2000a). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54–67.
- Ryan, R. M., Deci, E. L. (2000b). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-Being. *American Psychologist, 55*(1), 68-79.
- Scheines, R.; Leinhardt, G.; Smith, J., & Cho, K. (2005). Replacing lecture with web-based course materials. *Journal of Educational Computing Research, 32*(1), 1-26.
- Schunk, D. H. (2000). *Learning theories: An educational perspective* (3<sup>rd</sup> ed.). Upper Saddle River, NJ: Prentice-Hall.
- Schunk, D. H. (2004). *Learning theories: An educational perspective* (4<sup>th</sup> ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Skinner, E. A., wellborn, J. G., & Connell, J. P. (1990). What it takes to do well in school and whether I've got it: A process model of perceived control and children's engagement and achievement in school. *Journal of Educational Psychology, 82*(1), 22-32.

- Smith, V. L. (2003). *Analysis of locus of control and educational level utilizing the internal control index*. Retrieved April 24<sup>th</sup>, 2006 from <http://www.marshall.edu/etd/masters/smith-valerie-ma-2003.pdf>
- Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257-285.
- Sweller, J. (1989). Cognitive technology: some procedures for facilitation learning and problem solving in mathematics and science. *Journal of Educational Psychology*, 81, 457-466.
- Sweller, J., Chandler, P., Tierney, P., & Cooper, M. (1990). Cognitive load and selective attention as factors in the structuring of technical material. *Journal of Experimental Psychology: General*, 119, 176-192.
- Sweller, J., van Merriënboer, J. J. G. & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10(3), 251-296.
- Sweller, J. (1999). *Instructional design in technical areas*. Camberwell, Australia: ACER Press.
- Tabbers, Martens and van Merriënboer. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Psychology*, 74, 71-81.
- Todman, J., & Lawrenson, H. (1992). Computer anxiety in primary schoolchildren and university students. *British Educational Research Journal*, 18(1), 63-72.
- van Merriënboer, J.J. G., Schuurman, J.G., De Croock, M.B., & Paas, F. G. W.C. (2002). Redirecting learners' attention during training: Effects on cognitive load, transfer test performance and training. *Learning & Instruction*, 12, 11-39.
- van Merriënboer, J. J. G., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *ETR&D*, 53(3), 5-13

- Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., & Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic effects of intrinsic goal contents and autonomy-supportive contexts. *Journal of Personality & Social Psychology*, 87, 246-260.
- Wallen, E. S. (2002). *The effect of different types of hypertext annotations on vocabulary recall, text comprehension, and knowledge transfer in learning from scientific texts* (Ph.D. dissertation, The University of New Mexico, United States – New Mexico). Retrieved Oct.30 2005, from ProQuest Digital Dissertations database. (Publication No. AAT 3077182).
- Wallen, E. S., Plass, J.L., & Brunken, R. (2005). The function of annotations in the comprehension of scientific texts: Cognitive load effects and the impact of verbal ability. *ETR&D*, 53(3), 59-72.
- Woolfolk, A. (2004). *Educational psychology*. New Jersey: Person Education, Inc.
- Yeh, Y. & Wang, C. (2003). Effects of multimedia vocabulary annotations and learning styles on vocabulary learning. *CALICO Journal*, 21(1), 131-44
- Yeung, A. S. (October, 1997). *Reading English as a second language with vocabulary definitions: Cognitive load effects on comprehension and vocabulary learning*. Paper presented at the "Our Schools Our Research" Conference. New South Wales, Australia.
- Yeung, A. S., Jin, P., & Sweller, J. (1998). Cognitive load and learner expertise: Split-attention and redundancy effects in reading with explanatory notes. *Contemporary Educational Psychology*, 23(1), 1-21.

- Yeung, A.S. (1999). Cognitive load and learner expertise: Split-attention and redundancy effects in reading comprehension tasks with vocabulary definitions. *Journal of Experimental Education, 67*(3), 197-217.
- Yeung, A.S., Lee, C.F.K., Pena, I. M., & Ryde, J. (January, 2000). *Toward a subjective mental workload measure*. Paper presented at the International Congress for School Effectiveness and Improvement. Hong Kong, China.
- Yumuk, A. (2002). Letting go of control to the learners: the role of the Internet in promoting a more autonomous view of learning in an academic translation course. *Educational Research, 44*(2), 141-156.