

ENRICHING CRITICAL THINKING AND LANGUAGE LEARNING WITH  
EDUCATIONAL DIGITAL LIBRARIES

by

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## ABSTRACT

As the amount of information available in online digital libraries increases exponentially, questions arise concerning the most productive way to use that information to advance learning. Applying the earlier information seeking theories advocated by Kelly (1963), Taylor (1968), and Belkin (1980) to the digital libraries experience, Carol Kuhlthau created the inquiry-based information search process (ISP) model. This ISP model describes thoughts, actions and feelings in six stages of inquiry: initiation, selection, exploration, formulation, collection, and presentation. This study investigated the value of an organized educational digital library in supporting and improving English Foreign Language (EFL) student's critical thinking skills. The study also considered if critical thinking skills and English language skills can be improved simultaneously in the appropriate learning environment.

A quasi-experimental pretest/posttest design was utilized. Participants were 98 Taiwanese freshmen majoring in Applied English. Two groups were compared in their ability to cultivate critical thinking. One approach used traditional open access to information plus training in critical thinking. The other used a structured approach to accessing and organizing information from an online digital library as well as training in critical thinking. A One-Way ANCOVA and an Independent-Samples t-test were used to examine the two groups on their 1) critical thinking skills, 2) English reading comprehension, and 3) attitudes in EFL classrooms. Bivariate correlation was employed to evaluate the relation between critical thinking and English reading comprehension.

Results indicated that the experimental digital library group ( $M=11.69$ ) significantly outperformed the traditional group ( $M=10.61$ ) in critical thinking;  $F(1, 95)$

= 4.10,  $p < .05$ . The digital library group ( $M = 11.69$ ) also outperformed the traditional group ( $M = 10.23$ ) on English reading comprehension;  $F(1, 95) = 14.72$ ,  $p < .05$ . There was a positive relationship between critical thinking and English reading comprehension ( $r = .212$ ),  $p < .05$ . Also, students in the digital library group ( $M = 38.57$ ), had better learning attitudes toward the intervention training program than did the control group ( $M = 35.59$ );  $t(96) = 2.48$ ,  $p < .05$ .

Students who used structured search strategies with digital libraries had higher critical thinking performance and more positive attitudes toward their learning experience. Educators should adopt training strategies that engage learners in every stage of inquiry process, from identifying a topic and selecting what to investigate, to formulating a focused perspective and presenting their final product. Further studies are needed to determine if the benefits of structured search strategies with digital libraries extends to other settings, cultures and grade levels. Collecting and analyzing examples of student projects may provide additional insights into the development of critical thinking skills.

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# CHAPTER I

## INTRODUCTION

In the era of the rapidly evolving Internet and of information society, information technology has made a great impact on education, and has changed the way we think and learn. Students should prepare for new knowledge, new skills, and new ways of learning in this vibrant environment. It is essential for teachers to move beyond only teaching how to use technology tools to how to integrate technology with the learning process in order to engage students to learn with a more creative and meaningful way.

### **Statement of the Problem**

As an English as a Foreign Language (EFL) country, Taiwan is facing a major challenge while the government has made numerous attempts to prepare with the necessary English skills for world competition. As Lee (2007) pointed out, in the conventional EFL classroom, teachers tend to place a lot of emphasis on the passive teaching strategy which is focusing on sentence analyses and grammar structures in reading passages and have students memorize vocabulary words. This kind of traditional language instruction has been limited by the difficulties imposed on sparking and maintaining students' interest in global cultures and languages (Pasch & Norsworthy, 2001). Students often learn English vocabulary and sentence structures from the grammar books, textbooks, or English learning magazines under the exam-driven curricula. Consequently, the challenge of English language education in Taiwan is that, with the traditional teaching methods which simply aiming at acquiring the development of basic skills, students do not have enough opportunities to engage in

inquiry learning to expand their knowledge, promote independent and extensive reading, and emerge their critical thinking skills from gaining a deeper understanding of the concept.

Since the traditional method of passive learning is no longer sufficient to prepare students to survive in today's world, computer-assisted language learning (CALL) has represented an alternative approach for EFL learners and instructors. However, while teachers and students benefit from an abundance of resources of that the web provides, they alike face the challenge of discovering usable material. Even the most popular search engines like Google and Yahoo return an overwhelming amount of unwanted results. Furthermore, online information is not necessarily accurate or truthful; it is hard for students to locate material that matches their language ability when they study on their own. Besides, surfing English Websites does not result in meaningful learning until learners articulate an intention to use that information to do something meaningful. In a manner, digital libraries, unlike other Web-based materials, provide authoritative, organized and effective authentic materials, can play a crucial role in education (Chen & Chen, 2010).

In light of the vast potential in education, digital libraries have emerged as an instructional tool for institutions and educators to facilitate language teaching and learning with the use of an extensive amount of authentic media and comprehensive searching capabilities (Fitzgerald, 2007). William Arms defines a digital library as a “managed collection of information, with associated services, where the information is stored in digital formats and accessible over a network” (Arms, 2000, p. 2). The principal difference between traditional libraries and digital libraries is that digital

libraries offer a greater opportunity for users to retrieve and use information through the internet, which extend the roles and values of traditional libraries (Marchionini & Maurer, 1995a). Digital libraries are considered extensions of the physical library, not replacements, provide immediate access to a range of resources not available in physical collections.

Unlike the traditional instruction in language teaching that only allow students to passively learn from the main sources of words and pictures in textbooks, and the sound of the instructor's voice, digital libraries make it possible for students to exposure to and immersion in other cultures and languages at the click of a mouse with no additional or incremental costs. In this kind of digital environment, the possibility for a foreign language student to become an active learner has been opened up. With this powerful educational technology tool, students' interest in foreign language learning will be increased, and they can manipulate target language information and transform it into meaningful ways of critical and creative thinking in the learning process (Bush & Terry, 1997).

Instead of simply viewed as another source of information for students, digital libraries should viewed as resources that provide new opportunities for students to engage in inquiry learning to make a significant contribution. Kuhlthau (1997) defines an effective digital library environment should support learners as they progress through six-step information search process: 1) task initiation, 2) topic selection; 3) prefocus exploration, 4) focus formulation, 5) information collection; and 6) presentation. The Information Search Process (ISP) provides insight into how to guide students in the inquiry process by describing thoughts, actions and feelings in these six

stages of inquiry (Kuhlthau, 2010). That is, in the inquiry process involving identification of a topic, organizing information into a coherent structure in the digital library environment, students will be able to select a subject area to inspire real investigation and prompt new understanding of their own interests. In order to complete specific assignments through these steps, learners need to develop self-paced and self-directed learning, which is “an ongoing process of acquiring and utilizing information” (Gunn, 2002, p. 28). In other words, digital libraries enable learners to concentrate on constructing new knowledge in the stages of the inquiry process by establishing a plan, strategically conducting research to collect information, and evaluating the results of the information found to solve the given academic problems, which requires learners to interpret a learning problem based on multiple information sources. Such learning process might engage learners in practice in using critical thinking skills (Wu, 2008).

As Gunn (2002) states, digital libraries have been demonstrate as a venue for higher-level thinking skills and higher-level learning such as problem-solving, decision-making, critical thinking, or creative thinking. As a teaching tool, an educational digital library is not just a storehouse of information, instead, it has a place in pedagogical methods, allows students to enhance critical thinking through investigating problems, engaging in researches, gathering information, organizing and analyzing information (Borgman et al., 2000). Hopefully, in the inquiry process of finding the most appropriate resources that are relevant to learners’ individual goals, interests, and current knowledge among numerous of links returned by a search service in educational digital library, they can develop and use a relatively high level of

domain knowledge and thinking skill in order to finish the tasks. In this way, higher order learning skills promoted by higher-order thinking skills which in turn empower students to achieve higher levels of English language proficiency (Renner, 1996).

However, in EFL classrooms, inquiry into educational digital libraries use as an activity to promote critical thinking, which is often considered as one of the desirable goals, is extremely scarce. To familiarize students with basic English grammar, sentence structures, and vocabulary words in order to pass the examinations, Taiwanese teachers tend to avoid incorporating critical thinking, problem solving or creative thinking skills into their classroom. Given the positive results from the previous studies of educational digital libraries in variety fields, it is necessary to pursue the investigation on the value of educational digital libraries beyond the traditional EFL learning models.

### **Purpose of the Study**

The purpose of this study is twofold: first, to investigate if an organized educational digital library can be a valuable technological tool to support and improve EFL student's critical thinking skills, and second, to explore if critical thinking skills can be taught and developed along with improving English language skills, with a special focus on EFL learning. To support teachers and students effective use of online digital resources, the National Science Digital Library (NSDL) was utilized in this research. The NSDL was established by the National Science Foundation (NSF) in 2000, directs users to exemplary resources for science, technology, engineering, and mathematics education and research. By conducting searches, obtaining information, solving problems and creating projects in the digital library environment, EFL users



can acquire knowledge of a specific subject through the medium of English language. Consequently, good thinking skills can be taught, developed and improved along with promoting their English language skills through what they learn in the classroom and connected to real life in an integrated and contextualized way.

To these purposes, different resources that support students learning was the factor that differentiates two groups; an experimental group and control group; to evaluate the differences in learning performance including critical thinking and English reading comprehension, to investigate the learners' learning attitudes, as well as to examine the relationship between the reading comprehension and the critical thinking skills. This study requires each student to finish three assignments that enable students to identify their own beliefs by collecting information and responding questions. Students in the experimental group were taught by finding an abundance of high-quality resources stored in the National Science Digital Library while those in the control group were taught by finding information using open resources not limited to any general search engines or traditional books. The expectation of this study is that the use of critical thinking skills in the context of inquiry-based exercise for digital libraries in the EFL classroom can viewed as a key vehicle in promoting English reading comprehension. English teaching should not simply aiming at supporting partial knowledge and acquiring the development of basic skills, but rather promoting independent and extensive reading, and empowering student's potential as an active learner to pursue knowledge in their future life.

## **Research Questions and Research Hypotheses**

To accomplish the purpose of this research, the study addressed the following research questions, and the hypotheses that corresponded to the research questions are also listed as follows:

RQ1: Is there any difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?

H1: There is a difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels.

Independent variable: different resources.

Dependent variables: the scores of critical thinking test.

RQ2: Is there any difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?

H2: There is a difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels.

Independent variable: different resources.

Dependent variables: the scores of English reading comprehension test.

RQ3: Is there any relationship between the English reading comprehension scores and the critical thinking scores?

H3: There is a positive relationship between the English reading comprehension scores and the critical thinking scores.

Two variables: English reading comprehension scores and critical thinking scores.

RQ4: Is there any difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non- digital library) group?

H4: There is a difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non- digital library) group.

Independent variable: different resources.

Dependent variables: the scores of students' learning attitudes.

For these four hypotheses, the improvement at the  $p < .05$  level was considered statistically significant.

### **Significance of the Study**

The significance of this study is threefold. First, this study points out the problematic areas of contemporary EFL classroom and the challenge that EFL educators and students face while utilizing Internet as a teaching tool in Taiwan. With better information about basic process of English reading comprehension, teachers can design and implement appropriate multimedia technology to promote students' understanding of author's content, and to help students generating the concept to gain a new perspective on their own life experiences. Instead of helping learners to build a stock of words and memorizing grammar structural rules, this study focuses on using Educational Digital Libraries as an effective instructional means to enhance language learning. The learning

experience emphasize on the process by which students acquire knowledge from different resources, with concept development and comprehensive understanding as the goals.

Second, in the practical perspective, the findings of this study provides an alternative model for how to integrate technology with the learning process in order to engage EFL students to learn more meaningfully. Specifically, the findings may shed light on how an educational digital library can be an effective means of language learning and critical thinking. The information gained from this study can empower EFL teachers to move from teacher-directed exercises to student-centered experiences. In this way, teachers can equip students with an appropriate and effective means in grasping the main point of what they are reading. Eventually, students acquire the higher-level English reading comprehension and critical thinking skills; thereby learn to be active, independent readers in their academic English learning areas.

Lastly, this study examines the relationship between EFL students' critical thinking and reading comprehension. Hopefully, teachers can integrate digital libraries into classes that help students locating appropriate material, exposing them to contemporary language usage, and giving them the tools to study independently. Thinking emerges naturally from purposeful activity; thus, language learners can be facilitated and tailored to fulfill their special needs through purposeful searching and browsing of a particular subject. With better information about how to integrate Educational Digital Libraries into the classroom, teachers can design appropriate techniques to promote students' critical thinking, and laying the foundation for their overall English reading comprehension skills.

## **Definition of Dependent Variables**

The following terms appear throughout the study and provide understanding and meaning of the text.

**Critical thinking.** The term “critical thinking” refers to “reasonable and reflective thinking that is focused upon deciding what to believe or do” (Ennis, 1989). An essential part of critical thinking is internalizing and becoming comfortable in exhibiting the attitude and disposition of critical thinker. It implies “curiosity, skepticism, and reflection” (Pasch & Norsworthy, 2001). In this study, critical thinking is defined as a purposeful, reasonable, and active process of identifying an encountered problem, searching for information, interpreting evidence to make further inference, and evaluating possible solutions to increase the probability of a desirable outcome.

**Reading comprehension.** Reading comprehension refers to the process that students learn to “develop their own interpretations of what they read, to question, rethink, and elaborate upon the ideas and information drawn from their reading experiences” (Applebee, et al, 1985, p. 8).

## **Summary**

As more and more Internet access is given in the EFL classrooms, there is a need to guide the students to confront the mass of online resources and avoid being overwhelmed by it. In addition, teaching for thinking has become a major agenda since it is the EFL teacher’s task to prepare students for the world outside their classroom. This study attempts to determine whether a difference exists in critical thinking, English reading comprehension and learning attitude when different resources were used as learning support with inquiry process and explorative topics. Also, the

relationship between EFL students' English reading comprehension scores and critical thinking scores was analyzed. The findings in this study provide reference for effective use of Educational Digital Libraries in English teaching and learning and critical thinking in Taiwan. Furthermore, the results of this study allow for testing if critical thinking can be taught to EFL students beyond the traditional learning models.

## **CHAPTER II**

### **REVIEW OF LITERATURE**

#### **Introduction**

Over the last decade the steady advance of computer and network technologies has radically changed the potential for support of schooling (Honey et al., 1999). Among a variety of technology tools, digital libraries and the internet are two of the key pieces that make more and more quality educational resources available for instruction (Marshall et al., 2006). However, their effectiveness is often debated and technologies by themselves rarely have substantial impact on teaching and learning even if electronic resources can help achieve positive learning outcomes. Given the challenging task EFL learners are faced with in developing higher level of English reading comprehension and critical thinking skills, an effective educational digital library as an instructional means was integrated with inquiry process to enrich students learning in this study. Although previous studies have explored the effects of digital libraries activities on multiple areas, this study was the first to explore the effects of digital libraries activities on critical thinking and English reading comprehension in a Taiwanese college EFL course. In order to derive a theoretical framework that addresses the hypotheses in this study, this chapter reviews relevant literature consisting of three main areas: 1) Educational digital library; 2) Critical thinking; and 3) the relationship between English reading comprehension and critical thinking.

## **Educational Digital Library**

**Background Information.** Libraries are important institutions that store collections, preserve culture and information, provide information services, and assist academic activities. Via digitization of resources and the development of networks, the primary missions of traditional library processes and services have changed dramatically. The principal difference between traditional libraries and digital libraries is that digital libraries offer a greater opportunity for users to retrieve and use information through the Internet, which extend the roles and values of traditional libraries (Marchionini & Maurer, 1995a). Digital libraries are complex and advanced distributed information spaces that have proved useful for long-term preservation of information digitization (Russell, 1998) and offered real-time interactive services enable public to easily manage and monitor vast quantities of multimedia data via the Internet (Ferguson & Bunge, 1997). A simple yet effective definition of a digital library was given by William Arms, creator of D-Lib Magazine, as a “managed collection of information, with associated services, where the information is stored in digital formats and accessible over a network” (Arms, 2000, p. 2). Digital libraries, not only can support, facilitate, and enhance the formal learning of the institutions as physical libraries, but also contain more up-to-date information than physical collections. Their sources can be searched more efficiently than those in physical libraries, and the information they contain can be updated more frequently (Gunn, 2002) which extent the roles and the values of traditional libraries.

**The need of digital library.** While the innovation of the Internet technology brings revolutionizing potential for learners to seek solutions of their learning tasks by



engaging them with a wealth of learning resources, such as information gathering, designing investigations or interpretation of findings (Krajcik, 2002), the Internet also presents a significant challenge which is quite different from traditional sources. Only a decade ago, the key skills in terms of information dealt with how to find useful information from a limited universe of possible sources (Pasch & Norsworthy, 2001). Today, the opposite problem is faced in many respects. Although the Internet has gained a primary place in research methods, the lack of uniform standards and the ease of access have made the Internet a powerful but uncertain medium (Graham & Metaxas, 2003). As learners can easily access real time stock quotes, read the current day's newspapers from around the world, consult encyclopedia entries, look up a book of online library catalogs, or take a virtual tour through a museum, they also wade through the instantaneous changing information on the Internet and find what they want. Learners need to face the problem that search the information through the Internet and verify every page of each linked site would be, which is an incredibly time-consuming task because Web sites change overnight and expand at exponential rates (Graham & Metaxas, 2003).

As Fraser & Deane (1999) pointed out, students must develop extensive information gathering skills and become experts in learning from ill-structured resources. Pasch & Norsworthy (2001) argued that in this Internet era, the challenge is how to confront this mass of data and how to avoid being overwhelmed by it. Not surprisingly, one of the primary concerns of instructors who utilize the Internet in their instruction is that their students lack the necessary skills to critically evaluate and use online resources (Hargis, 2001). Therefore, it is crucial to have a proper system or a technology tool for educators to address the concerns of helping students to develop

the ability necessary to deal effectively with information overload and the varying quality of online resources. This is where digital libraries come into play.

To choose proper technology tools, Graham & Metaxas (2003) proposed that an internet portal should promote the development of and provide access to the highest quality content on the Web. Jonassen (2000) promotes "Using computers as Mindtools" to enhance meaningful learning. Mindtools represent a new and alternative way for using computers in education to engage students in critical thinking while they represent what they know, not what the teacher know. Jonassen argued that teachers should choose proper computer application to make the most effective uses of computers in classrooms "for accessing information and interpreting, organizing, and representing personal knowledge. Just as carpenters cannot build furniture or houses without a proper set of tools, students cannot construct meaning without access to a set of intellectual tools to help them assemble and construct knowledge" (Jonassen, 2000, p. 4). To illustrate the point of view by choosing proper technology tools to facilitate the process of seeking information, digital libraries allow people to locate relevant information sources in a diverse world of information (Jayawardana et al., 2001), can equip users to use search engines more effectively compared to those unmonitored source of information. Chu et al. (2008) claimed that with well-structured and well-managed content in e-libraries, learners can access a universe of digital information on the Internet. According to Chen & Chen (2010), digital libraries facilitate better learning than other open digital resources stored on the Internet. From this point of view, digital libraries are not viewed simply as another source of information for students, they can make a significant contribution if they can served as authoritative,

organized and effective tool providing learners with an unchallenging environment, allowing students to concentrate on subject content rather than battling with the medium itself (Beiers, 2000).

**Advantage of digital libraries for student learning.** Digital libraries enable teachers and students around the world to use content from vast amount of reliable resources in critical and creative ways that we could never imagine just few years ago. For example, users in France, Taiwan and Vietnam can all use the same historic document, take a virtual tour through a museum or read an essay on Shakespeare from the National Archives in the United States at the same time, which might not available or required a field trip in the past. Summing up the vast new possibilities opened up for educators and learners by the advent of digital libraries, Fox & Marchionini (1989) concluded:

Digital libraries can be among the most complex and advanced forms of information systems because they often involve collaboration support, digital document preservation, distributed database management, hypertext, information filtering, information retrieval, instructional modules, intellectual property rights management, multimedia information services, question answering and reference services, resource discovery, and selective dissemination of information. (p.29)

Marchionini and Maurer (1995b) also proposed that one of the greatest benefits of digital libraries is that digital libraries can empower the user and promote formal, informal and professional learning missions. Furthermore, as the demand of supporting customized educational content and learning activities to meet the needs of a diverse student population increased (Jonassen & Grabowski, 1993), educators are investigating how educational technology can enable a new genre of personalization tools. In a manner, digital libraries can response to this demand because these powerful

electronic portals are customized for the learning needs of specific classes, teachers, or student groups (Gunn, 2002).

According to Arms (2000), digital libraries have several benefits for learners include the following: 1) Bringing the library to the user; allow them to use at school or at home; 2) Improving access; allowing for powerful searching and browsing; 3) Enabling easier and wider sharing; being able to share unique collections both locally and internationally; 4) Making up-to-date information accessible any time, anywhere, in any format; 5) Maintaining the collection; 6) Saving money; opening twenty-four hours a day at a relatively low cost; 7) Improving preservation; copying, storing and maintaining digital copies or rare information reduces the fear of maintaining one physical object permanently.

Undoubtedly, well-designed digital libraries can provide enriching and interactive experiences for all learners to explore the world around them. Teachers and students at all levels can greatly benefit from large volume of high-quality educational materials that has been carefully authored and stored in the educational digital library environment. Additionally, a user's learning attitude can be changed for the better (Thong, Hong & Tam, 2004) and become more positive and enthusiastic about the value and the quality of the discovered learning resources of digital libraries (Recker et al, 2005).

Although considerable research has focused on the creation and management of digital libraries, only within the last several years, few studies have addressed the effectiveness of digital libraries on educational practices. Leazer et al. (2000) presented the impact of digital libraries of the Alexandria Digital Earth Prototype (ADEPT), which is an extension and enhancement of the Alexandria Digital Library (ADL), on

student learning using numerous research methods. Oldenettel et al. (2003) investigated the Learning Environment Based on Non Educational Digital Libraries (LEBONED) project, which focused on integrating digital libraries and their content into web-based learning environments. Sumner and Marlino (2004) demonstrated the value of digital library using a series of three thought experiments, and concluded that digital libraries are cognitive tools, component repositories, and knowledge networks. In the case of providing an environment for active learning in Singapore's educational system, Goh et al. (2005) depicted a web-based application called GeogDL, which help students to prepare taking a national examination in geography by providing access to a digital library of geographical resources. Furthermore, Marshall et al. (2006) conducted a research that connects the design elements of the GetSmart system to targeted concept-map-based learning processes in a digital library environment. Chu et al. (2008) created an e-library of butterflies and ecology with metadata to teach elementary school students observation and classification skills in a mobile learning environment. Based on this literature survey, educational digital libraries indeed play an increasingly important role in teaching and learning. Hence, the research literature on digital libraries continues to grow as we learn more about how users around the world use this technology, and how developers can improve digital libraries to meet users' information needs.

**The role of digital libraries in language learning.** The rise of computer-assisted language learning (CALL) has brought a new dimension into language classrooms. Among several possibilities of CALL tools, the use of internet has become one of the most popular tools to increase EFL students' motivation in learning English

because of its abounding resources. By reading newspaper articles, listening to audio recordings, communicating with other learners, and other online exercises, the World Wide Web offers learners a wealth of the target language material all over the world. Numerous of research has been explored the experiments with the effect of Internet in EFL learning. Jou (2009) stated that with the Internet, teachers can easily find materials, work on class projects, design courses and learn computer applications. Moreover, students can research and transform information into a more sophisticated understanding via the Internet by doing an authentic task (March, 2003). However, it does not necessary follow that all learning outcomes are sufficient and remarkable while teachers expose students to innumerable language resources offered by the World Wide Web.

In the case of examining the effects of time spent surfing English Websites on the English writing performance, Hung (2008) found that the more time the students spent surfing English website, the less accurate was their writing. Hung argued that it is possible that students may simply have caught what they needed or downloaded the programs they like without paying much attention of verifying the accuracy of online English articles and information. Jonassen (2000) stated that although “Internet is an enormous repository of information that can either enhance or impede learning, depending on how it is used, but Internet is not a Mindtool” (p. 174). In other words, surfing English Websites does not result in meaningful learning until learners articulate an intention to use that information to do something meaningful.

According to Wu & Witten, there are some challenges occur when teachers and students trying to discover usable material on the Web. First, teachers may not have enough time to find appropriate materials that meet their teaching needs and match

students' ability. Second, teachers must evaluate the website that they are going to use in the classroom is a safe and reliable educational environment, which has a congenial interface, and does not contain offensive or threatening items. Third, while constructing language learning tasks based on the Internet, the teachers must ensure that the language is accurate without any grammatical or spelling mistakes. Teachers also need to make sure that the pages are still there and the content is intact before every class. Finally, when learners study on their own, it is very hard for them to locate material that matches their language ability, and examining through search results to distinguish useful material rolls back their interest and motivation. It is possible that students may come across material with unsuitable content by accident. (Wu & Witten, 2006)

Another problem may arise as Chen & Chen (2010) pointed out; with an overwhelming amount of information that changes frequently on the internet, learners can be easily lost in the hyperspace while finding and digesting suitable resources. Additionally, students may not have the ability to justify the quality of resources that they found on the internet. Specifically, the challenge for students is how to confront the mass of online resources and avoid being overwhelmed by it while learning the necessary skills to handle, select, evaluate, digest, and apply the information that they found. Therefore, schools and educators should carefully choose the appropriate CALL means to maximize every student's potential in learning English. In a manner, the expectations of digital libraries are high because they can be served as an innovation learning approach which is effective, organized, and authoritative (Chen & Chen, 2010).

In the article “*The role of digital libraries in teaching and learning*”, Marchionini & Maurer (1995a) identifies many advantages in using digital libraries for teaching and learning including special benefits for language classes. As Fitzgerald (2007) pointed out, digital libraries can support language teaching and learning through the use of authentic media, comprehensive searching capabilities, and automatically generated precision-targeted exercise material. Furthermore, digital libraries are ideal places for learners to gain a deeper sense of a special culture of a target language, which shaped by specific ways of seeing and interpreting the world. As Vygotsky (1978) and Jean Lave (1991) pointed out, real learning is situated only in specific cultural environments. By developing students’ knowledge of culturally situated learning, students can construct their own belief and make valuable connection with mentors around the world, along with correctly interpret the target language and master skills in appropriate communication. In the digital libraries environment, teachers can introduce the people, special events, history, environment, art, literature, and music to EFL students by creating and presenting in diverse media—text, images, audio, video, and maps, which focus on the learner in an effort to improve the way students absorb, retain, and transfer knowledge.

In this safe and reliable educational environment, teachers can access information from the digital libraries and turn into meaningful language exercises. Learners access target language in genuine and realistic contexts; enrich their learning experience which prepares them for what they will encounter in the real world. By integrating digital libraries into classes, teachers can engage students in locating appropriate material, exposing to contemporary language usage, and using proper tools



to study independently. Through purposeful searching and browsing of a particular subject, digital libraries can facilitate and tailor the special needs of language learners (Wu & Witten, 2007). In this way, important skills of critical thinking, problem solving, and creative thinking can be taught and developed in the process of extensive reading, evaluating content of texts, selecting relevant information, and synthesizing materials in the educational digital library environment along with improving their English language skills through what they learn in the classroom and connected to their real life.

#### **The constructive process of inquiry supported by educational digital library.**

To describe how people acquire knowledge and to suggest improved methods for education, a variety of learning theories have been proposed. These theories can be organized into three groups: Behaviorism, Cognitivism, and Constructivism (Mishra, 2002). As we know, a learning theory is the foundation for a proposed teaching approach. Since the purpose of this study was to investigate how educational digital libraries may support adaptive pedagogical use for critical thinking and language learning in an EFL classroom, a brief review of constructivism was provided in this section because it has been identified as a useful paradigm in the development and evaluation of online learning environments (Mishra, 2002). However, Behaviorism and Cognitivism were not reviewed as the foundation of the proposed teaching practice in this study, although they are still viable perspectives with important implications for education.

The constructivist model of learning emphasizes on the process by which people acquire knowledge, with concept development and comprehensive understanding as the goals (Fosnot, 1996). Jonassen (2000) claims that learners construct knowledge most

naturally and completely while they are constructing some artifact. Papert (1990) coined the term to describe “the theory that knowledge is built by the learner, not supplied by the teacher” (p. 3). In a constructivist perspective, Jonassen (2000) argued that technologies can support meaningful learning when students learn with technology instead of learn from technology. And students learn with technologies when computers support knowledge construction, explorations, learning by doing and conversing. According to Dalgarno (2001), Constructivism focuses on three main ideas which are important in a digital library context. First, there is no single “correct” representation of knowledge; second, people learn through active exploration; and third, learning occurs in a social context.

In terms of combining constructivist learning ideals and experience in digital libraries domain, “Constructivism is particularly well suited to the new environment of abundance of digital libraries.” (Kuhlthau, 1997, p. 711). Based on solid research findings grounded in a constructivist approach to learning, Kuhlthau creates a model of the inquiry-based information search process (ISP) that provides insight into how to guide students in the inquiry process, which describes thoughts, actions and feelings in six stages of inquiry, namely initiation, selection, exploration, formulation, collection, and presentation (Figure 1).

<b>Information Search Process Model</b>
<b>Task initiation</b> Students are puzzled when a problem is introduced to them.
<b>Topic selection</b> To identify a broad, general area for investigation.
<b>Exploration</b> To form a focus, which requires reading, reflecting, and identifying a personal perspective or focus for the work.
<b>Formulation</b> To gather appropriate information and to construct a story or narrative according to their personal perspective.
<b>Information collection</b> To collect information to support the chosen topic.
<b>Presentation</b> To encourage students to share their ideas, collected resources, and final projects to their peers.

Figure 1. Information Search Process Model

For the first three stages, initiation, selection and exploration, Kuhlthau's process highlights the identification and clarification of a topic. The initiation phase occurs when a problem is introduced to students and they are often puzzled. In the selection stage, a broad, general area for investigation is identified. Students generally have a sense of optimism regarding the accomplishment of the task. In this stage, students may become anxious if they didn't choose the topic quickly. The exploration phase is to form a focus, which requires reading, reflecting, and identifying a personal perspective or focus for the work. Therefore, it is identified as the most difficult part of the process. For the last three stages, Kuhlthau views as organizing information into a coherent structure. The focus formulation refers to gather appropriate information and to construct a story or narrative according to their personal perspective or sense of meaning from the encountered

information. The information collection means to collect information to support the chosen topic. The last stage “presentation” encourages students to share their ideas, collected resources, and final projects to their peers.

The learners’ knowledge grows as they involve in information seeking and interact with the information. Throughout the six stages of inquiry process, the student engages in critical thinking skills such as identifying an assumption about information, interpreting the certain information, making an inference, and evaluating an argument. Therefore, the inquiry-based ISP was adopted in this study to help learners to cultivate critical thinking skills. With considerable guidance and intervention throughout the inquiry process, an effective digital library environment can make a significant contribution providing new opportunities for students to engage in constructing personal understanding and transferable skills. Without guidance, digital libraries can contribute very little to the process of learning that leads to a copying and presenting assignment if they are viewed simply as another source of information.

In sum, an effective digital library environment should support learners as they progress through the inquiry-based ISP. As a knowledge constructivist tool, educational digital libraries can support complex learning process that requires many skills of learners; enable learners to make a plan to meet the goal, to search and collect relevant information, to construct the knowledge of the content, and to develop and represent new perspectives using variety of multimedia including text, graphics, pictures, video, and audio. In this way, knowledge is built by learners, not provided by teachers (Jonassen, 2000), that is, learners engage themselves in manipulating and reflecting on what they know instead of reproducing what someone else tells them.

**Selection of educational digital library.** As we know, digital libraries have the potential to change significantly the fundamental aspects of the classroom in ways that can have an enormous impact on teaching and learning. To reach the goals of formal education, new pedagogical methods should accompany digital libraries as an emerging technology for education (Sharifabadi, 2006). Most importantly, digital library learning environments must provide a meaningful connection between learning activities and resources. Therefore, in the process of researching and writing this study, a dozen of Educational Digital Libraries was reviewed around the world to meet the goal of this study. In the end, the National Science Digital Library (NSDL) was chosen and the elaboration of selection criteria to arrive at the site is included below.

A couple of first thoughts on educational digital selection are that the website needs to be stable over a long period of time and it needs to be one of the nationwide educational digital libraries (EDL) that offers free online materials for education and research. The NSDL is a large educational digital library, contains the necessary breadth and depth of scientific, pedagogical content and cultural treasures to support learning and teaching in educational settings, which can promote independent, and extensive reading while students are exposing in the vast amount of authentic materials. Base on the guidelines of the DLESE Community Review, digital resource collections are required to include the following five elements to inspire confidence among the user: a) scientifically accurate, b) pedagogically effective and well-documented, c) easy to use, d) motivational for learners, and e) robust as digital resources (Kastens, 2005, p. 38).

In order to pick out what we saw as the best or the most appropriate digital library for the purposes of this research. The second thing that needs to point out is to investigate how educational digital libraries may support adaptive pedagogical use in EFL learning situations. Although originally, NSDL is a place that created to meet the goal for students and educators to find exceptional education resources in science, technology, engineering, and mathematics, it makes it natural and meaningful to introduce the culture of the target language to EFL learners. Learning a topic (such as wild animals or aliens) that they are interested through the medium of a foreign language, and learning a foreign language by studying a particular subject will makes language learning more interesting and motivational. Furthermore, the materials used in NSDL consist plenty of primary authentic texts produced for native speakers, which enable EFL students immersed in the foreign language environment while learning the content of variety areas. Therefore, NSDL is an educational digital library including extensive materials that provide cultural context, background, alternative points of reference and worldview from target language speaking country which can offer readers the fullest possible set of critical reading experiences.

Third, as Kuhlthau (1997) stated, an effective digital library environment should support learners as they progress through six stages of inquiry, namely task initiation, topic selection, exploration, focus formulation, information collection, and presentation. For these steps, NSDL can support as a tool to help students to identify a topic, to search information purposefully, to explore a particular topic, and to find the right information amidst a huge amount of digital material. As learners progress

through these steps, they can practice focusing on organizing information into a coherent structure and become involved in thinking processes.

## **Critical Thinking**

**Definition of critical thinking.** Critical thinking is a somewhat elusive concept; one that often seems to mean different things to different people. It is a whole way of approaching knowledge and the thought process itself rather than viewing as a fad that has somehow suddenly popped onto the scene. Therefore, it is necessary to trace centuries back to the roots of critical thinking and gain a deeper understanding of what this concept is all about. Then address to the issue why introducing critical thinking is still important in schools today.

The critical thinking foundation laid by Socrates was credited with discovering a method for using “deep questions” as a way of challenging various claims to knowledge. Nowadays, "Socratic Questioning" is known as critical thinking teaching strategy that highlighted the need in thinking for clarity and logical consistency. Followed by Socrates' thought of critical thinking, Plato emphasized that things not only have a superficial appearance, only the trained mind is prepared to see a deeper reality that lies beneath the surface. He expanded that anyone who aspired to understand the deeper realities, to think systematically, to trace implications broadly and deeply, the real or beneath-the surface reality can be apprehended (Pasch & Norsworthy, 2001).

Upon the notions of critical thinking, it is William Graham Sumner who first carried the contributions in the area of critical thinking to the field of teaching and education. The crucial point that he addressed to the institutional role of the school in society is that the tendency of the human mind is to think ethnocentrically (Pasch &

Norsworthy, 2001). That is, people often ignore the existence of alternate ways of thinking in different epochs and places. Instead, they think along lines that predominate in the society and the culture where they grew up. For William Sumner, critical thinking is “the examination and test of propositions of any kind, which are offered for acceptance, in order to find out whether they correspond to reality or not. The critical faculty is a product of education and training. It is a mental habit and power. It is a prime condition of human welfare that men and women should be trained in it.” (Sumner, 1940, p. 632) What Sumner called for is not only to integrate critical thinking into education, but also to incorporate as a lifelong project that people should carry with them long after finish their formal schooling.

Later, critical thought was extended even further into the areas of cognitive and intellectual development by Jean Piaget. He believed that good critical thinking must attempt to get away from egocentrism and ethnocentrism. Piaget established a close relationship between thinking and language. That is, students will be able to reason, to apply their thinking skill, within multiple points of view by exposing them to a language and culture that are different from their own through an approach landed in critical thinking (Suhor, 1984).

John Dewey, an American philosopher and educator, rejected authoritarian teaching methods. In his book *How We Think*, he defined critical thinking as "reflective thought" which consists of both an intellectual and an emotional component. He called for three essential activities, which are the active, persistent, and careful consideration of any belief, during the learning processes. Thus, critical thinking involves students examining a problem, finding a solution, reflecting and evaluating



from their success or failures (Dewey, 1982). Ennis (1989) defines critical thinking as “reasonable reflective thinking focused on deciding what to believe or do” (p. 4). He also suggests another related concept which is called “higher order thinking”. William Huitt (1998) defines critical thinking as a mental cognition activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action.

According to Bloom’s Taxonomy (Bloom et al., 1956), learners develop higher cognitive processes by filtering through large amounts of information until they construct an understanding of the problem and offer a solution. Bloom’s taxonomy is an ultimate theory that breaks down the critical thinking skills into different classification for learning, namely Knowledge, Comprehension, Application, Analyzing, Synthesis, and Evaluating (Table 1). Students progress through these six levels of the taxonomy from lowest to highest. Although critical thinking exist at every level, higher order thinking occurs at the last three elements: application, synthesis and evaluation, which are more difficult skills, the higher order thinking skills.

Table 1

*Bloom's Taxonomy*

Terms	Definitions
Knowledge	This includes the basic level of acquisition of knowledge; to observe and recall information, such as dates, events, places, and main ideas.
Comprehension	This relates how learners make the new knowledge of the material that you have read, heard or seen including understanding, interpreting, as well as comparing and contrasting information.
Application	This requires learners to carry out some task from what you have read, heard, or seen and apply to an actual situation; including the abilities to use information, concepts and methods in new situations.
Analysis	This deals with breaking what you read or hear into its component parts. Learners need to have the abilities to see patterns, to organize information, to recognize hidden meanings and to make the ideas ordered, related, or connected to other ideas.
Synthesis	This involves the ability to put together the elements students analyzed with other information to create something original. That is, learners need to use old information to create new ones, generalizing from given facts, and drawing conclusions
Evaluation	This occurs once learners have understood and analyzed what is said or written and the reasons offered to support it. Then they can assess this information and verify the value of evidence in order to make choices based on reasoned argument and whether or not to take a particular action.

During the 1990's a former student of Bloom, Lorin Anderson with David Krathwohl, a new group of cognitive psychologists, updated the taxonomy and published Bloom's Revised Taxonomy in 2001. Key to this is the change from nouns to verbs associated with each categories and a rearrangement of the sequence within the taxonomy. The new terms are Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating (Table 2). The revised taxonomy not only accounts for many of

the traditional classroom practices but also reflects relevance to the use of new technologies in this study.

Table 2

*Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001, p. 67-68)*

Terms	Definitions
Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
Applying	Carrying out or using a procedure through executing, or implementing.
Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
Evaluating	Making judgments based on criteria and standards through checking and critiquing.
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

The four-step critical thinking process that proposed by Wolcott and Lynch (2001), focuses on learning, suggesting that students generally begin their critical thinking at step one and, with practice, progress to step two and up the ladder. These four steps process includes:

Step 1: Identify the problem, the relevant information, and all uncertainties about the problem. (low cognitive complexity)

Step 2: Explore interpretations and connections. (moderate cognitive complexity)

Step 3: Prioritize alternatives and communicate conclusions. (high cognitive complexity)

Step 4: Integrate, monitor, and refine strategies for re-addressing the problem. (highest cognitive complexity)

The first step involves with identifying problems and relevant information and obtaining awareness that there is more than one correct solution. The second step includes recognizing one's own bias, articulating the reasoning associated with alternative points of view, and organizing information in meaningful ways. The third step requires analysis, developing the guidelines used for prioritizing factors, and communicating for a given audience and setting appropriately. The last step includes generating new information, explaining limitations of chosen solution Integrate skills into on-going process.

For Paul (1990), critical thinking is not only viewed as an analytical and evaluative process, it is also considered “the art of thinking about your thinking” (p. 32).

Critical thinking, as defined by Richard Paul (1990), is

the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action (p. 32).

In addition, he regarded the development of intellectual habits that enhance students’ abilities as critical thinkers, namely intellectual humility; intellectual courage; intellectual empathy; intellectual good faith; intellectual perseverance; faith in reason; and intellectual sense of justice (Paul, 1992).

Ruggiero (1989) concluded the process of critical thinking should involve of 1) deciding what you think and why you think it, 2) seeking other views and evidence, 3)

developing arguments using supportive evidence and 4) deciding which view is most reasonable. Facione & Facione (1994) emphasizes critical thinking as “the cognitive engine which drove problem-solving and decision making” (p. 1). Facione’s view of critical thinking as a construction and evaluation of arguments was later adopted in Delphi studies conducted by the American Philosophical Association to develop a consensus statement regarding critical thinking (American Philosophical Association, 1990). This definition was later used in the development of the California Critical Thinking Skills Test (CCTST) (Facione & Facione, 1994).

To sum up, when briefly look at this historical survey of critical thinking, there is an area of overlap between the literatures that mentioned above. In essence, critical thinking skills can be a teachable practice in the classroom followed by numerous of basic elements that arise again and again in both the historical and contemporary literature. In this study, the inquiry-based ISP was adopted to help learners cultivate critical thinking skills utilizing the support of different resources. Therefore, the definition of critical thinking is defined as a purposeful, reasonable and active process which results in identifying an encountered problem, searching for relevant information, interpreting evidence to make further inference, and analyzing and evaluating possible solutions to increase the probability of a desirable outcome.

**The need of critical thinking.** Gilster (1997) regarded critical thinking as the most essential skill when searching the Internet for information, because the Internet is full of false, incomplete and obsolete information. Research indicates that adult learners do not use critical thinking skills naturally, but these complex abilities develop in learners over time (Kurfiss, 1983; Paul, 1993). Scholars and educators believed that

this kind of complex reasoning process can be improved with practice (Paul & Elder, 2004; Van Gelder, Bissett & Cumming, 2004) and advocated that developing critical thinking skills are crucial to help students know how to learn and how to think clearly (Halpern, 1998).

Furthermore, the concept of critical thinking has been brought into the area of language teaching which is that learners can become proficient language users if they could display critical thinking through the language, besides just using the language and knowing the meaning (Kabilan, 2000). The significant relationship between language development and thinking skills has long been recognized by theorists and educators (Piaget, 1971; Vygotsky, 1962). Paul (2005) states that “a critical mind improves reading by reflectively thinking about what and how it reads” (p. 32). It is believed that engaging students in constant questioning in the reading process can help them progress in language learning.

**Critical thinking supported by digital library.** While using technology tools to support teaching critical thinking skills in the EFL classroom is a new trend in the education field, evidential research related to improving student’s critical thinking skills supported by digital libraries is lacking. In this study, enhancing critical thinking was focus on using an educational digital library as an effective instructional means emphasizing on the process by which students acquire knowledge, with concept development and comprehensive understanding as the goals; instead of requiring learners to build a stock of words, or memorizing grammar structure rules.

In order to provide an alternative model for integrating technology with the learning process to engage learners more mindfully and meaningfully, Jonassen (2000)

promotes the idea of using selected computer applications as cognitive tools, Mindtools, which is a tool that intended to engage and facilitate learner's cognitive processing. The goal of Mindtools is to make more effective use of the mental efforts of the learners. With a Mindtool, learning requires learners to think harder about the subject matter domain being studied than they would have to think without it (Jonassen, 2000). That is, students need to think deeply about the content they are learning when using Mindtools, and, these tools can facilitate the learning and meaning-making processes. Jonassen provided theoretical reasons for using mindtools including meaningful learning, knowledge construction, reflective thinking, cognitive partnership tools, and scaffold thinking. In a manner, educational digital libraries can be seen as mindtools that help learners to construct knowledge, organize information, support intentional information search, and create their own project that reflect their own perspective or understanding of ideas.

Similarly, the inquiry process proposed by Kuhlthau (2010), combining constructivist learning ideals and experience in digital libraries domain, suggests that students go beyond the familiar textbook mode of right and wrong answers to enter a realm of ambiguity. In addition, she argues that in the constructive process of inquiry involving identification of a topic, organizing information into a coherent structure in the digital library environment, students will be able to select a subject area in order to inspire real investigation and prompt new understanding of their own interest. As Kuhlthau stated:

Students learn to think through issues that do not have prescribed responses or preset solutions. Students learn to identify what is important to them, to construct new meanings, and to explain their new understanding to others in some way that is authentic to the topic. (1997, 711)

Moreover, Haury (1993) reported a number of benefits of inquiry-related teaching approaches, suggests that inquiry teaching techniques can foster scientific literacy, understanding of scientific processes, and critical thinking. In this study, the potential of digital libraries to advance critical thinking skills along with improve their English reading comprehension skills can be explained by the process of how students complete educational digital library tasks following the inquiry-based ISP. Kuhlthau (1997, 2010) argued that an effective digital library should support learners to finish the tasks through the six stages of inquiry: initiation, selection, exploration, formulation, collection and presentation. In order to go beyond the ability of locating information, competence in seeking meaning and understanding is required. To internalize the process of learning from information can help students to develop competency in deciding what is the best information for them and what is enough information for their ongoing process (Kuhlthau, 1997). In other words, through practicing the recursive element of inquiry process, not only students can be guided to become information seekers but also possess the ability to think critically about a topic. Specifically, learners need to practice their cognitive abilities to identify central issues or assumptions in an argument, conduct research, select proper information, evaluate conflicting claims, eliminate extraneous information, provide solid evidence of arguments and carefully decide whether to accept, reject, or suspend arguments. In this complex process, individuals need to read with a high level of comprehension, interpret a coherent framework and provide support for their conclusion, (Furedy & Furedy, 1985; Halpern, 1993; Halpern, 1996). As Kuhlthau stated, "Learning through information seeking promotes a change in a way of thinking about something" (1997, p. 711). The way and the process students learn and think about



something may present in different ways. Some changes are sudden, some are in a more subtle way over time, but nonetheless a significant increase in understanding and thinking ability takes place.

Neuman et al. (1997) cited numerous studies to advocate that within well-designed environments, such as digital libraries, students could use computer technology to learn traditional school subjects and higher-level thinking skills. These higher-level learning include problem-solving, decision-making, critical thinking, creative thinking and other metacognitive skills, as described by Lockett & Kuehl (2001). Chen & Chen (2010) suggest that organized resources stored in digital libraries aid learners in problem-solving process and increase learning efficiency. Apedoe & Reeves (2006) proposed that digital libraries are potentially powerful technological tools that can support inquiry-based learning teaching approaches which have been advocated among science educators to help promote students' critical thinking, conceptual understanding and scientific reasoning abilities. Obviously, digital libraries are powerful tools to aid in "question-asking, information-gathering, information-organizing, information analyzing, and question-answering processes of users" (Borgman et al., 2000, p. 232). Additionally, Lockett & Kuehl (2001) asserts that digital libraries such as the NSDL are well-positioned to support instructors focusing on teaching higher-order skills, not just discrete facts.

**Theoretical frameworks for data analysis of critical thinking.** While there are some overlaps among the dimensions of the definitions of the critical thinking, there are also subtle important differences between them because critical thinking is not an easy concept to define as it can mean quite different things to different people in

different contexts and cultures. Therefore, it is necessary to consider that all techniques and strategies employed for teaching critical thinking during 6-week session was appropriately cover all the dimensions of the critical thinking that was evaluated. That is, if teaching and assessment are not appropriately integrated, it would be difficult to see how well students achieve the intended goals and leads to failures as outcome.

In order to better understand the reciprocal relationships between the process of teaching and learning, the effects of the instructional approach, and assessment methodology, the theoretical frameworks for data analysis of critical thinking was discussed as below to enable students and teachers understand how to express very complex ideas and how these concepts can and should be put into practice.

Because teaching and testing for critical thinking can be a challenge for educators, it is crucial to integrate the theoretical framework into instructional activities to help educators to know what it means to teach and test for critical thinking. Although in this study, Bloom' taxonomy (1956) offers a straightforward way providing a definition of critical thinking and how critical thinking can be practiced in a digital library environment, this conception has problems when testing students' abilities in accord with Blooms' taxonomy of educational objectives.

First, it is meaningless to test students' "knowledge" level since the huge amount of information that return by the digital library makes it difficult and impractical for the student to try to remember and maintain all of the current relevant knowledge for their learning. According to Bloom (1956), the lower levels require less thinking skills while the higher levels require more. The knowledge level is discrete and mastery of one level, having a certain knowledge level does not insure that students can automatically perform

to higher levels. In another work, simply knowing the elements of a concept (knowledge) does not guarantee that students can understand and interpret the information (Comprehension), have the abilities to use concepts in new situations (Application), identifying main ideas (Analysis), produce something new (Synthesis) or verify the value of evidence (Evaluation). Although critical thinking skills are an integral part of both higher and lower order thinking; in most situations, it is not necessary that learning must start at the level of knowledge, and go through each level to reach the Evaluation level. Thus, instead of just evaluate what “knowledge” students have learned and remembered, it is more important to know if students have the ability to generate information (lower order thinking) in order to use those information to guide behavior and make decision (higher order thinking).

Second, the levels of Bloom' taxonomy are not “really hierarchical, but rather are interdependent” (Ennis, 1993, p.179), to wit, it is hard to say that if the levels of synthesis and evaluation generally require analysis or analysis generally requires synthesis and evaluation because the concepts of last five (comprehension, application analysis, synthesis, and evaluation) are too vague as a guide in developing and judging critical thinking assessment. In brief, it is difficulty to clearly label testable thing of “analysis”. Thus, when testing students' critical thinking, Bloom' taxonomy need to be elaborated to get the “correct assessing” (Ennis, 1993, p. 180) definition to fit the contemporary conception of critical thinking. The following definition seems to be more in accord with contemporary usage in a digital library environment with minimize confusion: critical thinking is a purposeful, reasonable, and active process which results in identifying an encountered problem, searching for information, interpreting evidence to make further

inference, and evaluating possible solutions to increase the probability of a desirable outcome. Skills involved in the learning process include assumption identification, inference, deduction, explanation, and argument evaluation, which are commonly tested in national-wide multiple-choice critical thinking tests (Ennis et. al, 1985; Facione & Facione, 1994; Norris & Ennis, 1989; Yeh, 2005; Watson & Glaser, 1980).

***Assumption identification.*** It is crucial to identify an assumption about information. Instead of simply accepting assumption from single resource as fact, students need to ask themselves, “Are they valid or not?”, “Do I need to investigate more facts and materials?” as they are searching and gathering information from the digital library. In this way, students can practice thinking through assumptions before using them as fact, otherwise, bad assumptions will lead them down the wrong path.

***Inference.*** Inference arrives at conclusions that are explanations or generalizations, which go beyond the reasons or evidence offered in their support. This skill can help students to aware of the reasoning and thinking processes by identifying the facts presented in a text and drawing conclusion. After gathering the information returned by digital library, students can examine if the information reasonable and think of if their personal experiences relate to those facts. It is a key skill for processing or synthesizing large amounts of information return by digital library. A good explanation or generalization should be true for all facts on which it is based.

***Deduction.*** Deduction is a type of inference. Deductive inference arrives at conclusions that follow necessarily from the reasons given. Accepting the reasons means that the conclusion must be accepted. This skill can be practiced in a digital library environment by realizing the thinking process in which students identify the general

principles presented in multiple sources, evaluate those facts, and then narrow it down to a specific conclusion from them.

***Explanation.*** To interpret the choosing certain information, students require a greater depth of understanding. In a digital library environment, not only students need to have the ability to summarize and rephrase the information into their own words, but also to be able to create, modify and refine searches to suit their search needs.

***Argument Evaluation.*** The key concept of argument evaluation is to fully evaluate evidence before accepting it. When presented with an argument, it is necessary to understand all elements before commenting on it. This can be done through carefully identifying and reconstructing the most relevant information that gathered from the digital library. Furthermore, students can evaluate whether their final project shows insight, depth and understanding connected with the topic by checking the information selected from the resources as relevant or irrelevant.

In this study, Critical Thinking Test, Level 2 (Yeh, 2005) was used to evaluate EFL students' critical thinking. Comparing to other nationally available critical thinking assessments (The California Critical Thinking Skill Test, The Cornell Critical Thinking Test, The Watson-Glaser Critical Thinking Appraisal and The Ennis-Weir Critical Thinking Essay Test ), not only the test items of Yeh's Critical Thinking Test, Level 2 (CTT-II) correspond well with the learning objectives of this study but also Yeh's instrument was specifically designed to assess Taiwanese adult learners' critical thinking skills and its validity and reliability have been established (Yeh, 2005). The instrument was considered suitable for the age group of the students in this study and it was developed in Chinese, which eliminated the possibility of confounding language factors

with thinking skills. There are 30 multiple-choice questions in the instrument, which are equally divided into five critical thinking areas: assumption identification, induction, deduction, interpretation, and argument evaluation.

The five skills of the CTT-II provide the link between specific test items and learning objectives of this study. In order to carry out the critical thinking process effectively using an educational digital library in terms of inquiry process as proposed by Kuhlthau's, one needs practice the thinking skills including those required to identify an assumption about information, to interpret the choosing information, to draw conclusions from multiple resources, and to evaluate evidence before accepting it. Most importantly, it allows the instructor to develop a sense of student progress on the development of critical thinking skills and to establish some cause and effect between teaching techniques and students' outcomes of critical thinking skills. However, the skills articulated in criteria for rating critical and integrative thinking do not develop automatically as we get older and accumulate more experience. It needs to takes place within a certain context, which calls for strategies to keep the process on task with sustained effort.

### **The Relationship between English Reading Comprehension and Critical Thinking**

Because the amount of knowledge and information we receive is increasingly large, there are more and more problems and possibilities on our understanding that need to deal with daily. In 1984, national reports highlighted a renewed interest in college student's critical thinking skills as the primary aims of education. The report indicates that college students should adapt to a changing world and the essential component of this successful adaptation includes the skills "to think critically, to reason, to synthesize large quantities of new information" (National Institute of Education, p. 43). Substantial data represents

that most college graduates exhibit very limited skills for effectively addressing open-ended problems (e.g., Eyler & Giles, 1999; Wolcott & Lynch, 1997). Research indicates that adult learners do not use critical thinking skills naturally, but these complex abilities develop in learners over time (Kurfiss, 1983; Paul, 1993). Moreover, educators suggest that critical thinking can be applied in ESL/EFL contexts (e.g., Chapple & Curtis, 2000; Davidson & Dunham, 1997) and more research on the topic is needed in order to provide language educators with adequate information to make sound instructional decisions (Liaw, 2007). It is crucial for educators to design and use appropriate instructional methods and curriculum materials to increase EFL students' emphasis on critical thinking. Liaw argues that EFL teachers should pay serious attention to engage students in high-level cognitive and open-ended questions and give their students opportunities to develop higher-order thinking skills while learning the English language.

The thinking abilities that students have affect all aspects of communication including listening, speaking, reading and writing. In Taiwan, reading is one of the most important activities in an EFL classroom, where the possibilities of interacting with native English speakers are limited. Levine et al. (2000, p. 1) criticized that "The ability to read academic texts is considered one of the most essential skills that university students of English as a Second Language (ESL) and English as a Foreign Language (EFL) need to acquire". The more we read and listen, the more impacts on us. Dreyer & Nel (2003) lay out that the essence of reading is reading comprehension, which not only refers to academic learning in all subject areas but also to professional success and, indeed to lifelong learning. The written words surrounding us are not only as a source of information, but also as a means of improving and consolidating our knowledge of the

language. Neilsen (1989) emphasized comprehension for readers as finding “parallels between what they know and what the author know” (p. 8). Accordingly, the process of reading contains building connections between what is read and life experience, and creating new connections that go beyond and extend what was comprehended. Given Neilsen’s definition, basic process of reading comprehension indicates that readers understand author’s content, generate the concept and use it to gain a new perspective on their own life experiences. In a sense, to foster higher-level reading skills is not to place an emphasis on reading instruction that isolate from student’s daily life; instead, they must learn to value their own ideas that drawn from the materials they already read in a thoughtful, critical way (Applebee, et al, 1985). As a result, students learn to “develop their own interpretations of what they read, to question, rethink, and elaborate upon the ideas and information drawn form their reading experiences” (p. 8).

Researchers and theorists have shown that language and thinking skills are closely related and inseparable (Liaw, 2007, Piaget, 1971; Renner, 1996; Vacca, Vacca, & Gove, 1995; Vygotsky, 1962). The importance of promoting higher-order thinking skills in ESL and EFL classrooms have been emphasized and supported by numerous researches. The research by Davidson and Dunham (1997) indicated that critical thinking skills could indeed be taught as part of EFL instruction and the results revealed that the treatment group received additional training in critical thinking was outperformed than the control group received only content-based intensive English instruction. The evidence of the students’ use of certain thinking processes when engaged them in higher-level cognitive activity were also found in Huang’s (2003) study. The researcher stated that learners had



gained more opportunities for cognitive development through engaging in various thinking processes in the content-based language program.

Critical thinking expert Facione (2010) in his article “*Critical Thinking: What It is and Why It Counts*” asserts that there is a significant correlation between critical thinking and reading comprehension; “improvements in the one are paralleled by improvements in the other” (p. 18). Kamali’s (2011) study revealed that learners' critical thinking levels have significant effects on their reading comprehension ability when faced with unknown vocabulary items. Wu (2009) concentrates on teaching young adult literature (YAL) to English as second language students through extensive reading and concluded that using YAL to develop literacy can enhance cultural knowledge and foster critical thinking. Critical thinking is at the heart of advanced academic reading ability (Nunn, 2009); the presence of such a strong relationship may be due to the fact that critical thinking and reading are both cognitive abilities which have some identifiable cognitive skills in common (Kamali, 2011). According to Ryder & Graves (1994), these cognitive abilities involve “1) the ability of the learner to draw on background knowledge, 2) the ability of the learner to obtain or derive meaning from diverse sources of information, and 3) the ability of the learner to recognize or generate objectives that direct attention and regulate thinking” (p. 211). Similarly, Liaw argues that English language learners need to practice critical thinking in six cognitive domains of Bloom’s Taxonomy, namely knowledge, comprehension, application, analysis, synthesis, and evaluation (Liaw, 2007; Bloom, 1956). Liaw reports the findings of the study examining the effectiveness of promoting learners’ critical thinking skills and EFL skills with a content-based approach. Although the results revealed that there are no significant differences between the students’ critical

thinking scores before and after taking the lessons, the students' exercises of critical thinking skills in all six cognitive domains as categorized by Bloom (1956) showed that they performed significantly better on their English language proficiency test after the project.

With regard to teaching the process of critical thinking in language classroom, Pasch & Norsworthy (2001) argued that teachers can move beyond approaching students memorize grammar rules and vocabulary lists and introduce the worldview and alternative points of reference from other cultures. Fahim & Saeepour (2011) conducted a research study on the impact of teaching critical thinking skills on reading comprehension of Iranian EFL learners. The results showed that using critical thinking skills can help learners improve their reading comprehension as a general cognitive skill, and process information at deeper level. Sheikhy Behdani (2009) also carried out an investigation on the relationship between autonomy, critical thinking ability, and reading comprehension of the Iranian EFL learners. The results of data analysis revealed that there is a strong positive relationship between critical thinking ability of learners and their performance on reading comprehension. In other words, the higher the critical thinking ability, the higher the reading comprehension. Critical thinking is not simply a set of tools that should displace other aspects of the curriculum; rather, it should be used to complement with basic, text-book grammar and vocabulary. Students should equip the ability to question themselves about what they have read, to draw inferences, to analyze lines of reasoning, to apply logic, to weigh evidence, to evaluate authors' ideas and perspectives, and relate different information to each other in order to read critically (Moore, 2003).

In “*Argument analysis, critical thinking and reading comprehension*”, To-Dutka (1989) proposed the basis for an analysis that reveals the connection between critical reading and reading comprehension based on Toulmin’s (1958) argument structure model. According to To-Dutka, in terms of processing, “pre-existing knowledge enables readers to label and categorize incoming information to overcome the bottleneck situation when moving data from short-term memory to long-term storage and thereby promotes comprehension and learning.” (1989, p. 7) For the nature of the relationship between background knowledge and reading comprehension, To-Dutka (1991) views reasoning process as an essential of reading skills and states four major components of this process using Toulmin's (1958) argument structure model, namely, claim, ground, warrant, and backing. These components can also be translated into the following familiar reading terms: Identifying main ideas, finding supporting details and establishing the necessary justification by way of inference. The first component “claim” refers to grasp the argument's claim by identifying the main idea; the second component “ground” refers to establish the supporting details; the third component “warrant” refers to demonstrate the reasoning at work; the last component “backing” refers to justify the reasoning used with the appropriate background knowledge. Subsequently, students learn how different reading skills work with each other to bring about comprehension when reading instruction is offered within To-Dutka’s four-component framework; thereby, their reading comprehension skills will be enhanced if such critical thinking strategies are verbalized and shared. Overall, To-Dutka views teaching of reading comprehension as meaningful experiences, involving finding the main ideas, identifying supporting details,

drawing conclusions, and making inferences, in which students gain skills that aid in understanding something that is being read.

### **Summary**

This section has provided an overview that describes the educational digital library, the critical thinking skills and reading comprehension by defining the terms and then explaining how Educational Digital Libraries can make use of and improve the critical thinking skills and English reading comprehension of students. Through the inquiry-based ISP that prompts critical thinking in the digital libraries environment, students can learn the critical thinking skills necessary to identify an assumption about information, to interpret the choosing information, to draw conclusions from multiple resources, and to evaluate evidence before accepting it. The inquiry process of identifying a topic, finding the most appropriate resources returned by the digital library and organizing information into a coherent structure enable students to develop and use a relatively high level of domain knowledge and thinking skill. Also, the use of critical thinking skills in the digital library environment can be viewed as a key vehicle in promoting English reading comprehension. In this way, higher order learning skills promoted by higher-order thinking skills which in turn empower students to achieve higher levels of English language proficiency.

## CHAPTER III

### METHODS

#### Introduction

In order to secure answers to the proposed questions and fit the purpose of this study, Chapter three determines the research method procedurally.

The main purpose of this study was to investigate whether EFL students perform better in critical thinking and English reading comprehension when utilizing an organized digital library as an efficient means than those learning with other open resources.

Accordingly, the study addresses the following research questions:

RQ1: Is there any difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?

RQ2: Is there any difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?

RQ3: Is there any relationship between the English reading comprehension scores and the critical thinking scores?

RQ4: Is there any difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non- digital library) group?

Based on the theoretical framework that mentioned in Chapter two, this study presents a perspective through the constructive process of inquiry that prompts critical thinking in the digital libraries environment. With careful planning, EFL instructors can use an organized educational digital library effectively in the classroom to empower

students to gather information about specific topics, to develop deeper understanding of a text, to consider the source and question the veracity of what they read, and to gain an in-depth understanding to American culture. In this way, students can acquire critical thinking skills and higher-level of English reading comprehension; thereby learn as active, independent readers in their academic learning in all subject areas.

### **Participant**

College students from suburban area of Northern Taiwan were selected as an intact group in this study. Those participants who represent the population were young adult EFL students who had received at least 7 years of English as a required course since the official start of English education was shifted from junior high to the fifth grade in the year 2001. Two existing classes with 110 freshmen majoring in Applied English were recruited as subjects and 98 of 110 cases completed pre- and post-English reading comprehension tests, critical thinking tests and survey questionnaires at the end.

Human subjects approval was sought from the Institutional Review Board at the University of Kansas to protect all students who were involved in this research study. All the students were informed of the research purpose and possible benefits. This not only protects students' rights and privacy but also protects the researcher from legal and ethical missteps and safeguards them from the repercussions of such missteps (HSCL website). A consent form was translated from English version to Chinese version and given to all students who participate in this study prior to the pretest and intervention.

### **Instruments**

Three different data collection instruments were used in this study -- 1) English reading comprehension test; 2) Critical thinking test; and 3) Questionnaire survey. The

students' critical thinking skills were measured by CTT-II (Critical Thinking Test, level II), designed by Yeh (2005). English reading comprehension was measured by the TOEIC (Test of English for International Communication) practice tests adapted and modified from Barron's TOEIC Test (Lougheed, 2006).

Due to the fact that random assignment of treatment groups was impossible in the school setting, the researcher used pretest English reading comprehension scores of TOEIC and pretest critical thinking scores of CTT-II as covariates to assume equivalence between groups. The paper-pencil pre-and-post tests of English reading comprehension and critical thinking were administered separately in the beginning and at the end of the experiment.

**English Reading Comprehension Test.** The purpose of this test was to address the Hypothesis 2: "There is a difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels. " and Hypothesis 3: "There is a positive relationship between the reading comprehension scores and the critical thinking scores." The data from this task provides information about the effect of Educational Digital Libraries on EFL students' English reading comprehension skills as well as the relationship between English reading comprehension and critical thinking skills.

A standardized test of the TOEIC (Test of English for International Communication) from Lougheed (2006) was adapted in this study. The reading comprehension section of TOEIC is designed to measure the ability to read and understand short passages. According to the TOEIC Technical Manual, the TOEIC test

has been demonstrated as a valid measure of English language proficiency by extensive research. Also, the results show that TOEIC test scores are strongly related to scores on many other measures of English language proficiency. Five passages with controversial topics were adopted from the reading comprehension section of a TOEIC mock examination. Both the pretest and posttest were the same version contains 17 multiple-choice questions allowed subjects 30 minutes to answer those questions.

**Critical Thinking Test.** The purpose of this assessment was to address the Hypothesis 1: “There is a difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels.” and Hypothesis 3: “There is a positive relationship between the reading comprehension scores and the critical thinking scores.” The data from this task provides information for the effect of Educational Digital Libraries on EFL students’ critical thinking skills as well as the relationship between English reading comprehension and critical thinking skills.

Comparing to other nationally available critical thinking assessments (The California Critical Thinking Skill Test, The Cornell Critical Thinking Test, The Watson-Glaser Critical Thinking Appraisal and The Ennis-Weir Critical Thinking Essay Test ), the Critical Thinking Test, Level 2 (CTT-II) developed by Yeh (2005) was written in Mandarin Chinese can better fit the Taiwanese culture and language. More precisely, the evaluation procedure of the CTT-II is valid in this particular situation to the extent that “it measure what it is supposed to measure in that situation” (Norris & Ennis, 1989, p.49). In this way, the possibility of confounding language factors with thinking skills can be eliminated.



The scores of CTT-II were reported according to the items of questions the student gets correct, with a correct answer scored as 1 point and a wrong answer as 0. The possible total score is 30 points. The CTT-II was tested by the five-parameter Item Response Theory (IRT) model in the study of integrating e-learning into the direct-instruction model to enhance the effectiveness of critical-thinking instruction. The result shows that the scores of the test are equivalent across groups and it effectively discriminated between the high-ability group (upper 27%) and the low-ability group (lower 27%) on the ability to think critically. It also displayed an average level of difficulty and the subtest scores and total score were significantly correlated (Yeh, 2009).

As stated earlier, critical thinking in this study is defined as a purposeful, reasonable, and active process which results in identifying an encountered problem, searching for information, interpreting evidence to make further inference, and evaluating possible solutions to increase the probability of a desirable outcome. Considering the link between specific test items and learning objectives of critical thinking, the Critical Thinking Test, Level 2 (CTT-II) developed by Yeh (2005) is reasonable to utilize in this study. The CTT-II is based on the Cornell Critical Thinking Test (Ennis et. al 1985) and the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980), assesses five of the thinking skill areas including: assumption identification, inference, deduction, explanation, and argument evaluation. It consists of 30 multiple-choice items which are divided evenly into these five subtests. The detail descriptions of each section are provided as below:

***Assumption Identification.*** The purpose of assumption identification is to examine the ability to recognize and identify unstated assumptions in what people say. Examinees are presented a number of statements in which certain things are taken for granted. Each of the statements is followed by two proposed assumptions. Examinees are asked to make a decision to determine whether or not assumptions were necessarily taken for granted in the original statement. There are four choices: (a) Assumption 1 is valid, (b) Assumption 2 is valid, (c) Both Assumption 1 and Assumption 2 are valid, and (d) Neither Assumption 1 nor Assumption 2 is valid.

***Inference.*** The purpose of inference subtest is to test whether the examinee has the ability for judging the likelihood and given certain evidence to make a decision to determine if the conclusion is reasonable or not. Examinees are presented with passages containing information on different topic, follow by two inferences that someone might draw from the information in the passage. Examinees are to decide whether (a) inference A is reasonable, (b) inference B is reasonable, (c) both A and B are reasonable, or (d) neither A nor B is reasonable.

***Deduction.*** The purpose of deduction is to examine the ability to judge whether or not given possible conclusions follow from the statement. Examinees are presented a short paragraph follow by two possible conclusions from that paragraph. They are asked to consider the statements in the paragraph as true without exceptions then make a decision to determine if conclusion A is true, conclusion B is true or both of them are true.

***Explanation.*** The purpose of explanation subtest is to examine the ability to weigh evidence and to decide whether proposed conclusions follow beyond a reasonable doubt from the evidence. Examinees are presented with passage containing information

on different topics follow by two interpretations. The examinees are asked to judge whether or not each of the proposed conclusions logically follows beyond a reasonable doubt from the information given in the paragraph.

***Argument evaluation.*** The purpose of argument evaluation subtest is to examine the ability to differentiate strong statements of reasoning from those that are weak. Examinees are presented with questions about important issues follow by two arguments. Examinees are asked to accept the reason provided in the issues as true, and to make a decision whether argument A is strong, argument B is strong, both of them are strong, or both of them are weak.

**Questionnaire survey.** A questionnaire survey was used to collect data of the students learning attitude in this study. Because using educational digital libraries were a new experience for the students, it is essential to have a comprehensive understanding of students' responses toward learning using digital library. The questionnaire survey in this study was integrated from previous studies (Wu & Witten, 2007; Liaw, 2007; Chen & Chen, 2010), and was re-created by the researcher. The researcher asked the instructor and other professors in the department at the participating Taiwanese university for opinions and judgments as to whether the tests have content validity (Hughes, 2003). Modifications were made to reflect a reasonable domain of the content before conducting the study. It contains three sections; the first section is the demographic section asking for students' name, gender, age, and the years have been learning English; the second section contains 11 Likert-scale questions with five possible responses: 1) strongly disagree; 2) disagree; 3) neutral; 4) agree and; 5) strongly agree. The last section contains two open-ended questions concerning the

total hours students spent locating information and total resources they used for completing the assignments in order to obtain more information and revealed further insights. (APPENDIX B) The survey was translated from English to Chinese (Appendix C and D) and was given to all students who participated in this study.

## **Procedure**

The procedure for the research includes the following steps:

- 1.) The pretest of critical thinking and English reading comprehension were given to the students in both experimental (digital library) group and the control (non- digital library) group.
- 2.) The training program period was extended to 6 weeks from the beginning of December 2011 to the middle of January 2012. Each student required finishing assignments following the inquiry-based information search process. Students in an experimental group were taught using resources stored in the National Science Digital Library while those in a control group were taught by finding information using other open resources.
- 3.) The posttest of critical thinking and English reading comprehension were administered to the students in both experimental group and the control group after the training program.
- 4.) A questionnaire survey was administered to the students in both experimental group and the control group for a comprehensive understanding of the students' responses toward learning using different resources.

## Group design

A quasi-experimental approach was employed in this study. The research consisted three parts (Table 3); first, a pretest of critical thinking and English reading comprehension were giving to the experimental group and the control group in the beginning. Second, students in both groups were given different approaches to cultivate critical thinking skills. One approach used traditional open access to information plus training in critical thinking. The other used a structured approach to accessing and organizing information from an online digital library as well as training in critical thinking. Lastly, a posttest of critical thinking and English reading comprehension were giving to both groups at the end. Also, a questionnaire survey was administered to the students in both groups for a comprehensive understanding of the students' attitude toward learning using different resources.

Table 3

### Group Design

	Experimental group	Control group
In the beginning	a pretest of critical thinking and English reading comprehension	
Approach	traditional open access to information plus training in critical thinking	a structured approach to accessing and organizing information from an online digital library as well as training in critical thinking
At the end	a posttest of critical thinking and English reading comprehension a questionnaire survey concerning students' attitude toward learning using different resources	

## **Instruction**

In order to lower all participants' levels of frustration and anxiety, an easy-to-follow instruction based on Kuhlthau's inquiry-based information search process model was created by the researcher so that students knew when and what to do during the processes of learning. Besides, it helps students to change their reading behavior from the traditional instructor-centered model to an active and independent process; and to develop their critical thinking ability and English reading comprehension skills by collecting resources and organizing information in order to finish their own projects.

For students in the experimental group, this study utilized PBworks Wiki as a space to store the links of the resources and hold content. The use of the PBworks Wiki and NSDL is relatively simple, since no special computer skills are required to produce online content. The students in the experimental group received a short introduction and demonstration of using PBworks and NSDL covering the following sections:

1. Introduction to PBworks Wiki and National Science Digital Library

When users find a handful of resources for the content area that they have chosen to work on, PBworks Wiki provides a space for users to save their resources immediately for future modification in a simple way instead of writing down the notes with pencil and paper, or saving the URL with a bookmark and an email. PBworks Wiki is one of many types of wikis available. PBworks Wiki is a free service developed for educators and businesses. With PBworks, teachers and students are able to store and reuse online learning resources such as educational digital library to create instructional project pages.

2. Register with PBworks

To use PBworks, a user can first create a free account and login to edit and save his/her resource and content. In this study, it is not necessary for students to create an account personally, they only needed to provide their email address to the teacher, and the teacher invited the students through their email to access the PBworks page set up by the researcher.

3. Selecting resources and adding content to a project

In this study, students in the experimental group were limited to only search for NSDL resources. After finding the relevant information returned by NSDL, students needed to save the URL with proper link name and brief description of the resources to his/her own PBworks page.

4. Complete the projects

Each student had his/her own PBworks page created by the researcher. Students only need to enter the page and follow the instruction of inquiry process to complete the task.

## **Treatment**

Three instructional units were adopted from the textbook *Active Skills for Reading, Book 1* (Anderson, 2007), which covers a wide range of controversy issues including culture, technology, health, entertainment, and the environment. The topics of these three units are: Our Modern Lifestyle, Our Changing Diet, and Inventions (Table 4). Both of the experimental group and the control group were taught the same units.

In order to design and implement the activities carefully, the researcher discussed with the English teachers who were assisting in the recruitment of students for the

research with two considerations; first, whether the activities fit the level of students' English proficiency; and second, whether such flexible, less firmly structured learning would best suit the students' needs. Therefore, the activities were designed to stimulate students to think and learn through the use of the target language. In order to guide but not to control the process of learning, these three units were created as meaningful tasks. As students participated in the activities, they were practicing identifying their own beliefs that influence their interpretations of a text and developing a complex understanding of what they have read by finding different resources and adding important context.

Table 4

*Detailed Descriptions of Activities*

Topic	Main Tasks
Week 1 and 2: Our Modern Lifestyle	<ol style="list-style-type: none"> <li>1. Do you think that our lifestyle is detrimental to the environment? Why or why not?</li> <li>2. Choose three different ways in which you are interested in making changes of your lifestyle that will have a beneficial effect on the environment.</li> </ol>
Week 3 and 4: Our Changing Diet	<ol style="list-style-type: none"> <li>1. Do you believe that "You are what you eat"? Why or why not.</li> <li>2. Do you believe that "A person who doesn't eat meat can not get enough protein and be healthy"? Why or why not.</li> <li>3. List three ways on eating healthier for life.</li> </ol>
Week 5 and 6: Inventions	<ol style="list-style-type: none"> <li>1. Choose 6 of the top 20 inventions of the 20<sup>th</sup> century and write 1 complete sentence that describes how each of your chosen inventions makes our lives easier.</li> <li>2. Choose 2 inventions from your list of 6 that you compiled from the Top 20 inventions of the 20<sup>th</sup> century. Collect the information and write 2 sentences for each that describe the history of the invention.</li> <li>3. Choose an inventor of one of your Top 6 inventions and describe, in 1 paragraph, what drove them to discover their invention.</li> </ol>



## **Data analysis**

This study used quantitative measures to gather data from Taiwanese EFL students to analyze the effects of the educational digital library on their critical thinking ability and English reading comprehension skills. The students' gains in critical thinking skills were the main area of investigation; in addition, the improvement in English reading comprehension was also assessed and analyzed. A one-way Analysis of Covariance (ANCOVA) was conducted to test the mean differences of critical thinking and English reading comprehension scores between control group and experiment group. The SPSS data file includes: teaching method as a factor distinguishing among two groups; a covariate, the students' pretests; and dependent variables, critical thinking and English reading comprehension scores. Bivariate correlation analysis was used to find out the possibility of any correlation between English reading comprehension and critical thinking. All analyses were conducted using a .05 level of significance. Table 5 shows the summary of data sources and methods of analysis that were used for each hypothesis.

Table 5

*Summary of Data Sources and Methods of Analysis for Each Hypothesis*

Hypotheses	Data sources	Methods of analysis
Hypothesis 1: There is a difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels.	<ul style="list-style-type: none"> <li>The scores of CTT-II</li> </ul>	One-way ANCOVA
Hypothesis 2: There is a difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels.	<ul style="list-style-type: none"> <li>The scores of TOEIC</li> </ul>	One-way ANCOVA
Hypothesis 3: There is a positive relationship between the English reading comprehension scores and the critical thinking scores.	<ul style="list-style-type: none"> <li>The scores of CTT-II</li> <li>The scores of TOEIC</li> </ul>	Bivariate correlation analysis
Hypothesis 4: There is a difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non-digital library) group.	<ul style="list-style-type: none"> <li>The attitude survey</li> </ul>	<i>t</i> -test

## **Summary**

The purpose of this study was to investigate whether EFL students perform better in critical thinking and English reading comprehension when utilizing an organized digital library as an efficient means than those learning with other open resources. A quasi-experimental design with one experimental group and one control group was utilized for this study. Two existing classes with 110 freshmen majoring in Applied English were recruited as subjects in the study and 98 of 110 cases completed pre- and post-English reading comprehension tests, critical thinking tests and survey questionnaires at the end. A series of descriptive statistics, *t*-test, Bivariate correlation analysis, and a One-Way ANCOVA, were used to answer the hypotheses. Chapter Four will present the results of the study for each research question.

## CHAPTER IV

### RESULTS

#### **Introduction**

This chapter reports the results of whether a difference exists in Taiwanese college EFL students' learning performance in critical thinking and English reading comprehension, as well as their learning attitudes, when different resources were used as learning support with the same explorative topic. Also, the relationship between critical thinking and English reading comprehension was examined.

This chapter contains three sections. The first section presents the validity and the reliability of the instruments. The second section reports the demographic and background information of the participants. The third section is organized in line and reports the results with the four research questions.

#### **Reliability of Instruments**

The measurement of the Critical Thinking Test, Level 2, which has been specifically designed to assess Taiwanese college students' critical thinking skills, was used in this study. Cronbach's alpha ( $\alpha$ ) reliability was performed to test the internal consistency of the CTT-II. Table 6 showed that the overall Cronbach Alpha Coefficient of the test instrument was 0.651. The range of the reliability coefficients of the five subsections were between 0.497-0.680. Except for the ability of evaluation, the alpha reliability coefficients of the subscales tested were still within acceptable range. Although critical thinking tests generally have lower estimated reliabilities than other standardized tests (Norris & Ennis, 1989, p.49), the alpha reliability coefficient was rather low for the

ability of evaluation. Therefore, the results of analysis for this subscale should be interpreted with caution.

Table 6

*Reliability Statistics of Critical Thinking Test*

Scale	Cronbach's Alpha	N of Items
Assumption	0.678	6
Inference	0.680	6
Deduction	0.578	6
Explanation	0.628	6
Evaluation	0.497	6
Total	0.651	30

The measurement of English reading comprehension test was adapted from a validated instrument. Reliability analysis showed an acceptable consistency of this scale (Table 7). The Cronbach value of internal consistency for posttest was .719.

Table 7

*Internal Consistency Reliability Coefficients for English reading comprehension test*

Cronbach's Alpha	N of Items
0.719	18

The Cronbach's  $\alpha$  for the questionnaire survey is 0.954 (Table 8), which indicated an excellent consistency across the items that form this scale.

Table 8

*Internal Consistency Reliability Coefficients for the Attitude Questionnaire*

Cronbach's Alpha	N of Items
0.954	11

## Demographic and Background Descriptions of Participants

Originally, there were 110 participants participated in this research. However, 12 participants who did not complete the assignments, tests or survey were excluded from the results. Thus, 98 of 110 cases were used for data analysis in this study.

As described in Chapter 3, participant background data was collected to identify participant profiles based on demographic data asking for students' gender, age, and course name. A demographic survey was given to each student after the treatment intervention. Table 9 presents that 78.6 % of the participants (N=77) were females and 21.4 % of the participants (N=21) were males.

Table 9

### *Participants' Sex Distribution*

Sex	Frequency	Percent
Male	21	21.4
Female	77	78.6
Total	98	100.00

In terms of the distribution of age for participants (Table 10), 90.9% were between the ages of 18 and 19, while only 9.1% were between the ages of 20 and 21.

Table 10

*Participants' Age Distribution*

Age	Frequency	Percent
18	57	58.2
19	32	32.7
20	7	7.1
21	2	2.0
Total	98	100.00

In regard to the years students have learned English (Table 11), 58.2% of participants have learned English for 8-10 years, 25.5% of participants have learned English for 3-7 years, and only 16.3% of participants have learned English for 11-14 years.

Table 11

*Participants' Years learned English*

Age	Frequency	Percent
3.00	4	4.1
4.00	3	3.1
5.00	5	5.1
6.00	7	7.1
7.00	6	6.1
8.00	20	20.4
9.00	13	13.3
10.00	24	24.5
11.00	4	4.1
12.00	7	7.1
13.00	3	3.1
14.00	2	2.0
Total	98	100.0

## Results by Research Questions

This section reports the results to address the following research questions:

1. Is there any difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?
2. Is there any difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels?
3. Is there any relationship between the English reading comprehension scores and the critical thinking scores?
4. Is there any difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non- digital library) group?

**Research Question 1.** The research question targeted the exploration of the differences between the continuous dependent variable, students' critical thinking scores, with different resources that support students learning as the independent variable that differentiates two groups.

To assess the Hypothesis 1, "There is a difference on the critical thinking scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels". Firstly the scores of the five sections of CTT-II as defined by Yeh (2005), namely, assumption identification, inference, deduction, explanation, and argument evaluation were calculated for both groups (Table 12). With a correct answer scored as 1 point, and a wrong answer as 0, the possible total score for the CTT-II is 30 points.



Table 12

*Participating Students' Critical Thinking Skills Test Scores by Group*

		Assumption	Inference	Deduction	Explanation	Evaluation	Total
<b>Experimental</b>							
Pretest	M	2.12	2.94	2.03	1.03	1.74	9.84
	SD	1.04	1.46	1.10	1.06	0.91	2.65
Posttest	M	2.43	3.29	2.34	1.34	2.29	11.69
	SD	1.24	1.59	1.38	1.06	1.11	3.99
<b>Control</b>							
Pretest	M	2.15	2.87	1.83	1.17	1.77	10.29
	SD	1.20	1.44	1.11	1.05	1.16	4.05
Posttest	M	2.34	3.02	1.95	1.32	1.98	10.61
	SD	1.37	1.45	1.16	0.96	0.86	3.07

Table 13 shows the differences in pretest and posttest means of CTT-II for both groups. The results indicated that the control group outperformed the experimental group (10.30 vs. 9.84) on the pretest mean scores of CTT-II. This demonstrates that the control group had the higher baseline performance and, conversely, the experimental group had the lower baseline performance prior to the intervention. The result of the posttest indicated that the experimental group had the higher mean score (11.69) than the control group (10.61). The gain scores illustrated that the experimental group had the higher mean gain scores (1.85) than the control group (0.31).

Table 13

*The Differences in Pretest and Posttest Means of CTT-II by Group*

Group	Pretest		Posttest		Difference
	Mean	SD	Mean	SD	
Experimental	9.84	2.65	11.69	3.99	1.85
Control	10.29	4.05	10.61	3.07	0.31

The ANCOVA was conducted to determine whether a difference exists in students' critical thinking between two groups after co-varying out the effect of the pretest. Before conducting an ANCOVA, the homogeneity-of-slopes assumption (Table 14) was tested to find out if the interaction between the covariate and the factor in predicting the dependent variable is significant or not. The interaction source is labeled Groups \* PreCT. The interaction was not significant [ $F(1, 94) = 1.74, p = .19$ ].

Table 14

*Tests of Homogeneity of Slope*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3633.33	3	1211.11	10.96	.00	.26
Intercept	3046.99	1	3046.99	27.57	.00	.23
Groups	46.63	1	46.63	.42	.52	.00
PreCT	3266.23	1	3266.23	29.55	.00	.24
Groups * PreCT	192.22	1	192.22	1.74	.19	.02
Error	10389.46	94	110.53			
Total	149966.67	98				
Corrected Total	14022.79	97				

Since the interaction was not significant, ANCOVA was conducted. Though the pretest mean for the experimental group was lower than the pretest mean of the control group, the ANCOVA result (Table 15) showed that there was a significant difference on the CTT-II post-scores between two groups after controlled for the difference of pretest [ $F(1, 95) = 4.10, p < .05$ ]. The strength of relationship between the intervention and dependent variable was medium, as assessed by partial Eta squared, with the intervention factor accounting for 4.1% of the variance of the dependent variable, holding constant the grades of pretest (Partial  $\eta^2 = .041$ ).

Table 15

*Analysis of Co-variance (ANCOVA)*

Source	SS	df	MS	F	Sig.	Partial Eta Squared
Pretest	3130.40	1	3130.40	28.10	0.00	.228
Group	456.43	1	456.43	4.10	.046	.041
Error	10581.67	95	111.39			
Total	149966.67	98				

Also, the test assesses the difference between the adjusted means for the two groups, which are reported in the Table 16 as the Estimated Marginal Means (11.80, 10.50). The difference between the adjusted means for the two groups was not the same as difference between the means on the dependent measure (11.69, 10.61) in that the two groups had differing grades of pretest.

Table 16

*Estimated Marginal Means*

Group	M	SD
Experimental	11.80	0.44
Control	10.50	0.46

**Research Question 2.** The research question targeted the exploration of the differences between the continuous dependent variable, English reading comprehension scores, with different resources that support students learning as the independent variable that differentiates two groups.

To assess the Hypothesis 2, “There is a difference on the English reading comprehension scores between the experimental (digital library) group and the control (non- digital library) group after controlling for pre-intervention achievement levels”. Firstly the scores of the students’ pre- and posttests of English reading comprehension were calculated for both groups (Table 16).

Table 17

*Participating Students’ English reading comprehension Scores by Group*

Group	Pretest		Posttest		Difference
	Mean	SD	Mean	SD	
Experimental	8.96	3.08	11.69	2.61	2.73
Control	9.17	3.36	10.23	2.86	0.52

The results indicated that the control group outperformed the experimental group (9.17 vs. 8.96) on the pretest mean scores of English reading comprehension test. This demonstrates that the control group had the higher baseline performance and, conversely,

the experimental group had the lower baseline performance prior to the intervention. The result of the posttest indicated that the experimental group had the higher mean posttest score (11.69) than the control group (10.23). Also, the gain scores illustrated that the experimental group had the higher mean gain scores (2.73) than the control group (0.52).

The ANCOVA was conducted to determine if there was a difference on the English reading comprehension scores between two groups after co-varying out the effect of the pretest. Before conducting an ANCOVA, the homogeneity-of-slopes assumption (Table 18) was tested to find out if the interaction between the covariate and the factor in predicting the dependent variable is significant or not. The interaction source is labeled Groups \* Pretest. The result showed that the interaction was not significant [ $F(1, 94) = 1.70, p = .20$ ].

Table 18

*Tests of Between-Subjects Effects*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11976.92	3	3992.31	31.75	.00	.50
Intercept	11048.60	1	11048.60	87.87	.00	.48
Groups	790.46	1	790.46	6.29	.14	.06
Pre Tests	10011.00	1	10011.00	79.62	.00	.46
Groups * Pretest	213.56	1	213.56	1.70	.20	.18
Error	11819.06	94	125.73			
Total	389104.94	98				
Corrected Total	23795.98	97				

Since the interaction was not significant, ANCOVA (Table19) was conducted. Though the pretest mean for the experimental group was lower than the pretest mean of the control group, the ANCOVA result showed that there was a significant difference on the TOEIC post-scores between two groups after controlled for the difference of pretest [ $F(1, 95) = 14.72, p < .05$ ]. The strength of relationship between the intervention and dependent variable was moderately large, as assessed by partial Eta squared, with the intervention factor accounting for 13.4% of the variance of the dependent variable, holding constant the grades of pretest (Partial  $\eta^2 = .134$ ).

Table 19

*ANCOVA for English Reading Comprehension Test*

Source	SS	df	MS	F	Sig.	Partial Eta Squared
Pretest	10171.27	1	10171.27	80.30	.000	.458
Group	1865.38	1	1865.38	14.73	.000	.134
Error	12032.61	95	126.66			
Total	389104.94	98				

Also, the test assesses the difference between the adjusted means for the two groups which are reported in the output as the Estimated Marginal Means (Table 20). The difference between the adjusted means for the two groups (11.74, 10.17) was not the same as the difference between the means on the dependent measure (11.69, 10.23) in that the two groups had differing grades of pretest.

Table 20

*Estimated Marginal Means*

Group	M	SD
Experimental	11.74	0.28
Control	10.17	0.29

**Research Question 3.** Hypothesis 3 stated that there is a positive relationship between EFL students’ English reading comprehension scores and critical thinking scores, which was supported in this study. Pearson *r* values were calculated to determine the extent of the relationship of students’ posttest scores between reading comprehension and critical thinking. As indicated in Table 21, there was a small positive correlation ( $r = .212$ ,  $p < .05$ ) between the two dependent variables, English reading comprehension and critical thinking. According to Cohen (1988), a correlation of 0.5 is large, 0.3 is moderate, and 0.1 is small.

Table 21

*Pearson Correlations of Reading Comprehension and Critical Thinking*

	Reading Comprehension	Critical Thinking
Reading Comprehension		.212*
Critical Thinking	.212*	

\* Correlation is significant at the 0.05 level (2-tailed).

**Research Question 4.** To assess the Hypothesis 4, there is a difference in EFL students’ learning attitudes between the experimental (digital library) group and the control (non- digital library) group. Students in the experimental group ( $N = 51$ ) and control group ( $N = 47$ ) completed an end-of-project Survey (Appendix H), which

included 11 questions using a 5-point Likert-type scale (Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree). The questions in the student survey concentrated on a comprehensive understanding of the students' attitudes toward learning using different resources. Based on the descriptive results (Table 22), students in the experimental group (Mean= 38.57) had higher scores on learning attitude than those in the control group (Mean= 35.59).

Table 22

*Participating Students' Attitude Survey Scores by Group*

Group	Attitude Scores		
	N	Mean	SD
Experimental	51	38.57	4.50
Control	47	35.59	7.18

In addition, the mean rating on each survey question is presented in the Table 23. The findings revealed very positive responses from the participating students who were in the experimental group. Overall, on each survey question, the mean attitude scores were higher toward learning using resources stored in the digital library than using open resources not limited to any general search engine or books.



Table 23

*Mean Attitude Scores by Group*

Questions		M	SD
I gained English language skills through the learning process using this instructional approach.	Experimental	3.35	.522
	Control	3.26	.736
I gained content area knowledge about the topics using this instructional approach.	Experimental	3.61	.532
	Control	3.26	.765
I learn to make a plan to allow enough time to accomplish the tasks using this instructional approach.	Experimental	3.53	.578
	Control	3.32	.726
I gained a deeper understanding of the concept when involving in the activities.	Experimental	3.33	.516
	Control	3.23	.786
I learn research skills using this instructional approach.	Experimental	3.53	.504
	Control	3.17	.761
Learning English through using this instructional approach was interesting.	Experimental	3.24	.428
	Control	3.11	.667
The instruction had increased my motivation to learn English.	Experimental	3.49	.543
	Control	3.23	.729
The approach made English learning meaningful.	Experimental	3.52	.543
	Control	3.09	.717
The approach gave me opportunities to think.	Experimental	3.55	.541
	Control	3.21	.832
Overall, I thought that taking part in the activities enhanced my critical thinking ability.	Experimental	3.55	.541
	Control	3.17	.842
Overall, I thought that taking part in the activities helped me to gain confidence in my own English language ability.	Experimental	3.53	.542
	Control	3.21	.806

To examine the Hypothesis 4, “There is a difference in EFL students’ learning attitudes between the experimental (digital library) group and the control (non- digital library) group”, The independent-samples t-test results (Table 24) revealed that there was a significant difference in the responses between two groups in the measure of learning attitude [ $t(96) = 2.48, p = 0.015$ ]. Students in the experimental group ( $M = 38.57, SD = 4.50$ ) on the average had better attitude in learning compared to those in the control group ( $M = 35.59, SD = 7.18$ ).

Table 24

*Independent Samples t Test Results for Attitude by Group*

Group	Source	df	t	p
Experimental Vs. Control	Attitude Score	96	2.48	0.015

In order to obtain more information and provide further insights, two open-ended questions were asked concerning the total hours students spent locating information and total resources they used for completing the assignments (Table 25). The results showed that students in the experimental group on the average spent more time ( $M = 2.92, SD = 1.49$ ) and used more resources ( $M = 3.51, SD = 1.71$ ) doing their assignment than those in the control group (Time:  $M = 1.34, SD = 1.17$ ; Resources:  $M = 2.04, SD = 1.53$ ).

Table 25

*Participating Students’ Time and Resources by Group*

Group	Control		Experimental	
	Mean	SD	Mean	SD
Time	1.34	1.17	2.92	1.49
Resources	2.04	1.53	3.51	1.71

## **Summary**

This quasi-experimental design with one experimental group and one control group was to investigate whether EFL students perform better in critical thinking and English reading comprehension when utilizing an organized digital library as an efficient means than those learning with other open resources. The results supported the first hypothesis that there is a difference in the means of the critical thinking posttest scores between the experimental (digital library) group and the control (non- digital library) group, when controlling for pre-existing knowledge. The results also supported the second hypothesis that there is a difference in the means of the English reading comprehension posttest scores between the experimental (digital library) group and the control (non- digital library) group, when controlling for pre-existing knowledge. The results of the third research question indicated that there is a positive relationship between EFL students' English reading comprehension scores and critical thinking scores. The results also supported the fourth hypothesis that there is a difference in EFL students' learning attitudes between the experimental (digital library) group and the control (non-digital library) group. In addition, the results showed that students in the experimental group on the average spent more time and used more resources doing their assignment than those in the control group. While this chapter described the results of the present research, Chapter 5 offers an in-depth discussion of the findings, implications for EFL teachers, and recommendations for future research.

## CHAPTER V

### DISCUSSION

#### **Introduction**

This chapter provides the findings and interpretations from the statistical analyses of data presented in Chapter 4, and discuss how these findings can be related to the previous research. This chapter also provides the limitations and implications of the study and the recommendations for future research.

This study investigated whether a difference exists in critical thinking, English reading comprehension and learning attitude when different resources were used as learning support with inquiry process and explorative topic. Also, the relationship between EFL students' English reading comprehension scores and critical thinking scores was analyzed.

#### **Discussion of the Findings**

**Critical thinking.** The first research question looked at whether or not digital libraries provide opportunities to engage learners in practicing critical thinking, which was supported with the study data. For the purpose of this study, critical thinking is defined as a purposeful, reasonable, and active process of identifying an encountered problem, searching for information, interpreting evidence to make further inference, and evaluating possible solutions to increase the probability of a desirable outcome.

Analytical results showed that the experimental group's average pre-score was lower than the control group. However, the average post-score of the experimental group was higher than the control group. The mean gain from the pretest to the posttest for the

experimental group was higher than the control group. To determine whether the different resources influenced the performance of critical thinking after controlling for pre-intervention achievement levels, this study applied a one-way ANCOVA to the learning effect for the two groups. The results showed that the experimental group, which used digital library resources to support learning, had better learning performance in critical thinking than the control group, which used open resources to support learning.

This statistical finding was supported by other researchers such as Bloom (1956) and Carol Kuhlthau (1997 and 2010). The inquiry-based information search process proposed by Kuhlthau can be seen as a strong support to explain how a well-structured and organized educational digital library can support and improve learners' critical thinking in an innovative way as they progress through the stages of inquiry. Bloom suggests critical thinking as a teachable concept that can be assessed and evaluated, allowing students to delve deeper into what is going on through finishing tasks using higher levels of thinking. As students progress using an organized educational digital library following the stages of inquiry, they are practicing different levels of critical thinking. Therefore, critical thinking ability could be effectively taught through practicing the recursive element of inquiry process within an organized educational digital library environment.

**English reading comprehension.** The second research question investigated whether a difference exists in English reading comprehension when different resources are used as learning support with inquiry process and explorative topic. Analytical results showed that the experimental group's average pre-score was lower than the control group. However, the average post-score of the experimental group was higher

than the control group. Additionally, both groups improved after the treatment, with the experimental group gaining more in English reading comprehension. There was only a slight increase in the mean score of the control group. Since there was a difference in the means of the pretest scores, ANCOVA was calculated with the pretest scores functioning as a covariate to factor out the difference in participants' ability in English reading comprehension measured before the intervention. After factoring out the initial difference between the two groups, the ANCOVA results show that the participants in the experimental group outperformed those in the control group in English reading comprehension.

This statistical finding was supported by other researchers such as Wu and Witten (2007), Marchionini & Maurer (1995a), and Fitzgerald (2007) who identified many advantages in using digital libraries for language teaching and learning. These researchers agreed that learners supported by a digital library can acquire knowledge of a subject and improve their language ability at the same time. Teachers can access information from the digital libraries and turn into meaningful language exercises, which can engage learners locating appropriate material, exposing to contemporary language usage, and using proper tools to study independently.

**The relationship between critical thinking and English reading comprehension.** The third research question examined the correlation between critical thinking and English reading comprehension. The significant positive correlation between critical thinking and English reading comprehension confirmed results of previous studies indicating higher critical thinking was correlated with higher English reading comprehension (Liaw, 2007, Piaget, 1971; Renner, 1996; Vacca, Vacca, &

Gove, 1995; Vygotsky, 1962). Kamali (2011) argued that the presence of such a relationship may be due to the fact that critical thinking and reading are both cognitive abilities which have some identifiable cognitive skills in common. Similar to the findings in this study, Fahim & Saeepour (2011) indicated that using critical thinking skills can help learners improve their reading comprehension as a general cognitive skill, and process information at deeper level.

In sum, the results of data analysis revealed that there was a positive relationship between critical thinking ability of learners and their performance on English reading comprehension. That is, the higher the critical thinking ability, the higher the reading comprehension. Critical thinking is not simply a set of tools that should displace other aspects of the curriculum; rather, it should be used to complement with basic, text-book grammar and vocabulary. Students learn how different reading skills work with each other to bring about comprehension when students equip the ability to question themselves about what they have read, to draw inferences, to analyze lines of reasoning, to apply logic, to weigh evidence, to evaluate authors' ideas and perspectives, and relate different information to each other. (Moore, 2003, To-Dutka, 1991).

**Learning attitude.** The fourth research question examined EFL students' learning attitudes between the experimental group and the control group. The results supported the research hypothesis that, students in the experimental group had higher scores on learning attitude than those in the control group. Overall, on each survey question, the mean attitude scores were higher toward learning using resources stored in the digital library than using open resources not limited to any general search engine or books.

The findings in this aspect of the study are supported by the researchers such as Recker et al (2005), Thong, Hong and Tam (2004). The researches support the effect that exposure to the digital library can change a user's attitude for the better. In general, researchers have revealed participants were very positive and enthusiastic about the value and the quality of the discovered learning resources of digital libraries. It can be reasoned that using digital libraries was easier in terms of understanding the materials and obtaining relevant information. Therefore, it is a natural next step for students to reflect the concepts or ideas that they learned from their reading activities. This comprehension of content area knowledge, in turn, made the learning meaningful and enhanced the students' English language skills (Liaw, 2007).

**Additional findings.** In order to obtain more information and revealed further insights, two open-ended questions were asked concerning the total hours students spent locating information and total resources they used for completing the assignments. The results showed that students in the experimental group on the average spent more time ( $M = 2.92$ ,  $SD = 1.49$ ) and used more resources ( $M = 3.51$ ,  $SD = 1.71$ ) doing their assignment than those in the control group. Since the activity was limited to six weeks and the students could find resources and read information in detail at home, they had the choice to decide which and how many resources to use, and what information to extract. The findings in this aspect may reason that if the participants were more positive and enthusiastic about the value and the quality of the discovered learning resources, their willingness to invest time and efforts in a task increased, and their motivation to search different information resources in order to observe phenomena from diverse perspectives increased as well. On the contrary, if the



participants were frustrated by the wealth of available information, the negative experience of locating information may reflect on individual's willingness to invest time and efforts in a task. They might lack the motivation to search and read multiple resources following inquiry process in order to successfully achieve the task.

It is important for students to learn with technologies to facilitate learning as meaning-making processes and an enlightenment way of thinking. Without a considerable investment of time and energy, these processes and skills can not be developed. Moreover, it is crucial to encourage students to go beyond simply reading a single resource as solutions for their learning tasks. Once learners have a focus for their investigation, they are more likely to spend more time to look for information and locate additional resources to help them complete the academic task.

### **Limitations**

There are several limitations existing in this study to concern the internal and external validity of the results. Based on the definition of Cook and Cambell (1979), internal validity refers to the false positive or negative conclusions that were drawn from causal hypotheses; external validity refers to generalizability beyond specific populations of person, settings or groups that have a grounded existence.

First, the study could not adopt a random sampling procedure. The lack of random sampling decreased external validity and thus, the confidence to generalize the results to the population.

Second, some students may take extra English classes in school or after school; therefore, it was difficult to confirm that the progress was absolutely the result of the

program. It is also possible that the effect was due to student's growing older or getting more experienced between pretest and posttest.

Third, the results were obtained through a quasi-experiment, due to the lack of random assignment, cannot indicate a cause-and-effect relationship between variables as confidently as a true experiment would do. Therefore, a quasi-experiment would normally have less internal validity than a true experiment.

Fourth, the generalizability of this study was expected to apply to the intermediate level of English proficiency learners so the results may have difficulties generalizing to lower or higher level of English proficiency learners.

Fifth, this study was done by concentrating on the students of a suburban northern university in Taiwan; therefore, it would be hard to generalize the results to the Taiwanese urban and/or rural college students as well.

Lastly, the strategy of data collection in this study was limited to 6-week session of intervention program. By adding a long-term experiment to the research method, a more extensive study could provide more dimensions that leave out truly benefit from the strategies training and the valid effect of the study.

## **Implications**

The results of this study indicate three pedagogical implications: 1) educational digital libraries can be an effective means of critical thinking and language learning; 2) there is a need to integrate critical thinking into language teaching and learning, 3) organized digital libraries aid learners in inquiry process.

### **Educational digital library facilitate critical thinking and language learning.**

In supporting learning performance in critical thinking and language learning, digital library resources facilitate better learning than other open resources stored on the internet or traditional books. Neuman et al. (1997) found that within well-designed environments, digital libraries, students could use computer technology to learn traditional school subjects and higher-level thinking skills. Lockett & Kuehl (2001) asserted that digital libraries are well-positioned to support instructors focusing on teaching higher-order skills, not just discrete facts. Jonassen (2000) promotes the idea of using selected computer applications to make more effective use of the mental efforts of the learners and facilitate meaning-making processes. These arguments echo the findings in this study, in which the participants in the experimental group, who used digital library resources to support learning, had better learning performance in critical thinking and English reading comprehension than the participants in control group, who used open resources to support learning.

While reading or searching for information stored in other search engine such as Google or Yahoo, an abundance of misinformation are of little use and can make confusion between what is enduring and what is ephemeral especially when learners have poor critical thinking training. Effective use of educational digital libraries as an activity focuses on finding the most appropriate resources that are relevant to learners' individual goals, interests, and current knowledge in order to develop domain knowledge and thinking skill, can bring interesting content topics into the language classroom. Instead of helping learners to build a stock of words and memorizing grammar structural rules, emphasizing on the process by which students acquire knowledge, with concept

development and comprehensive understanding as the goals, students can use the target language to read, comprehend, generate, and express the concept from what they learn. Moreover, EFL teachers can design meaningful tasks and activities effectively to stimulate students to think critically through introducing the worldview and alternative points of reference from multiple resources using a well-structured digital library as a teaching and learning tool.

**Integrate critical thinking into language learning.** This study attempted to explore the relationship between critical thinking and English reading comprehension in learners of English as a Foreign Language (EFL).

The positive answer to the third research question echoes the argument that language and thinking skills are closely related and inseparable (Liaw, 2007, Piaget, 1971; Renner, 1996; Vacca, Vacca, & Gove, 1995; Vygotsky, 1962) and confirms the research findings that critical thinking is an ability which can be developed in individuals and can be applied in ESL/EFL contexts (Liaw, 2007, Chapple & Curtis, 2000; Davidson & Dunham, 1997). Facione (2010) asserts that there is a significant correlation between critical thinking and reading comprehension and improvements in the one are paralleled by improvements in the other. Renner (1996) argues that higher order learning skills promoted by higher-order thinking skills which in turn empower students to achieve higher levels of English language proficiency.

When students get engaged in an activity such as inquiry-based activities using digital libraries which requires learners to find the most appropriate resources among numerous of links returned by a search service in Educational Digital Libraries, they are practicing and developing a relatively high level of domain knowledge and thinking skill

in order to finish the tasks. Therefore, it is crucial for educators to design and use appropriate instructional methods and curriculum materials to integrate critical thinking into teaching and learning process to increase EFL students' emphasis on critical thinking, which can be effective for gaining knowledge and skills on English reading comprehension.

**Organized digital libraries aid learners in inquiry process.** A well-designed and organized digital library can increase the effectiveness of the constructive process of inquiry more than other open resources which are unstructured and distributed. It is very difficult for learners to follow the constructive process of inquiry supported by unorganized resources to have the experience of extensive exploration of ideas and formulation of thoughts before developing their own deep understanding of the topics and presenting it. In contrast, when learners used organized digital resources stored in digital libraries for learning, the effectiveness of inquiry process were increased by avoiding learning disorientation and cognitive loading. They become involved in thinking processes to evaluate whether the final project shows insight, depth and understanding connected with the topic. Several researchers, such as Apedoe and Reeves (2006), Edelson and Gordin (1996), Wang and Reeves (2004), Wallace et al (1996), and Kuhlthau (2010) have addressed the issues of the potential of digital libraries to support inquiry-based learning. To support the implementation of inquiry-based learning, an organized repository of resources, a digital library, can provide numerous high quality of resources for information gathering with confidence which is over the advantage of other open resources during inquiry activities. Instructors can create tasks in which students are

able to investigate a wide range of topics without creating an extraordinary amount of extra work.

An effective digital library environment can support learners as they progress through the constructive process of inquiry. As a knowledge constructivist tool, educational digital libraries can support complex learning process that requires many skills of learners; enable learners to make a plan to meet the goal, to search and collect relevant information, to construct the knowledge of the content, and to develop and represent new perspectives using variety of multimedia including text, graphics, pictures, video, and audio. In this way, knowledge is built by learners, not provided by teachers (Jonassen, 2000); engage them in manipulating and reflecting on what they know instead of reproducing what someone tells them.

### **Recommendations for Future Research**

This study examined the effectiveness of different resources, educational digital libraries and other open resources, on students' critical thinking, English reading comprehension and learning attitude in the English as a second language classroom. Some of the recommendations are listed as follows.

First, to examine the students' use of thinking skills, student involvement in the process of locating information was essential. As a matter of fact, critical thinking is a broad concept; the way and the process students learn and think about something may present in different ways. It is recommended to collect and analyze students' project samples to see if there is a consistency between the results of the Critical Thinking Skills Test and the findings from a close examination of students' project samples in order to reveal better insights into the students' use of different levels of thinking skills.

Second, the researcher suggests enhancing the model of inquired ISP by imposing the stage of Validation between the stages of Collection, and Presentation. The original model consist six stages: Initiation, Selection, Exploration, Formulation, Collection, and Presentation. However, as more and more people rely on Internet information despite evidence that it is potentially inaccurate and biased, a process to consider the credibility of web-based information is needed. For further research, it is recommended to use this revised ISP which includes a process of validating the accuracy and credibility of information (Figure 2).

<b>Revised Information Search Process Model</b>
<p><b>Task initiation</b> Students are puzzled when a problem is introduced to them.</p>
<p><b>Topic selection</b> To identify a broad, general area for investigation.</p>
<p><b>Exploration</b> To form a focus, which requires reading, reflecting, and identifying a personal perspective or focus for the work.</p>
<p><b>Formulation</b> To gather appropriate information and to construct a story or narrative according to their personal perspective.</p>
<p><b>Information collection</b> To collect information to support the chosen topic.</p>
<p><b>Validation</b> To consider and evaluate the accuracy and credibility of information.</p>
<p><b>Presentation</b> To encourage students to share their ideas, collected resources, and final projects to their peers.</p>

Figure 2 Revised Information Search Process Model

Third, as critical thinking can mean quite different things to different people in different contexts and cultures, it can be very difficult to measure. It is recommended to develop a critical thinking rubric as an auditing tool to capture this difficult to measure. The rubric can be used as a strategy with a variety of course assignments to evaluate which types of critical thinking abilities are developed and improved in an individual over time.

Fourth, this study suggests conducting research in the area of examining the effectiveness of inquired based ISP. It is recommended to examine the effects of an inquiry-based approach compared to that of a traditional learning approach on learning performance, attitude toward learning and inquiry ability.

Lastly, the participants in this study were mainly from the northern area of Taiwan. The results may not apply to learners from other areas of the island. For further research of this study, conducting a similar study several times to include more subjects from the southern part of Taiwan is needed to validate the results of this study.

## **Conclusion**

The present study aims to understand whether EFL students perform better in critical thinking and English reading comprehension when utilizing an organized digital library as an efficient means than those learning with other open resources. Based on a review of the literature, this is the first quasi-experimental research in language to explore the effects of educational digital libraries on EFL students' critical thinking and English reading comprehension.

Results indicated that the experimental digital library group significantly outperformed the traditional group in critical thinking. The digital library group also



outperformed the traditional group on English reading comprehension. There was a positive relationship between critical thinking and English reading comprehension. Also, students in the digital library group had better learning attitudes toward the intervention training program than did the control group.

With more experience in practicing critical thinking from purposeful and meaningful activity, language learners can be tailored to fulfill their special needs and achieve higher levels of English language proficiency. To facilitate students involved in practicing and developing different levels of thinking skill, extensive and independent reading from multiple resources within well-designed environments such as educational digital libraries is needed.

With effective use of educational digital libraries, a user's learning attitude can be changed for the better. If learners are more positive and enthusiastic about the value and the quality of the discovered learning resources, their willingness to invest time and efforts in a task increased, and their motivation to search different information resources in order to observe phenomena from diverse perspectives increased as well.

Consequently, it was easier for learners to follow the constructive process of inquiry supported by an organized educational digital library to cultivate critical thinking, in turn, made the learning meaningful and enhanced the students' English language skills.

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## APPENDICES

## Appendix A

### Reading Comprehension Test

Questions 1-4 refer to the following passage.

Hotels are changing their wasteful habits and getting involved in the move to save the environment. At major hotels throughout the world, guests are being greeted by shampoo and mouthwash in glass dispensers instead of elaborate plastic bottles. They are discovering recycling bins in their rooms, and are encouraged to use towels more than once before they are washed.

This green movement is becoming increasingly popular among tourists who look for service providers with an environmental conscience. The business of eco-tours is increasing rapidly. Travel agents are booking clients on “Save the Rainforest” expeditions and similar trips where the emphasis is on protecting the earth.

The tourists on these trips are given lectures on the influence of the loss of our planet’s natural beauty and what they can do to stop the damage. They do not need much convincing. The travelers on these excursions are already committed to environmental protection. In fact, a two-year study of litter in Antarctica found that the entire collection of litter left by visitors to the continent could be put in one plastic bag. Compare that amount of litter with what the average travelers finds scattered on the streets around a hotel, even an environmentally sensitive hotel.

1. What trend is currently affecting hotels and their guests?  
(A) Larger rooms  
(B) Better facilities  
(C) Lighter foods  
(D) Protecting the earth
2. What does the article imply about glass dispensers and re-using towels?  
(A) It’s a marketing gimmick.  
(B) It’s only effective on eco-tours.  
(C) It’s a wise choice environmentally.  
(D) Hotels can set consumer trends.
3. Which group would most likely be members of the green movement?  
(A) Fashion designers.  
(B) First-time visitors  
(C) Environmentally conscious travelers  
(D) Golf course owners
4. According to the article, eco-travelers should expect?  
(A) to find a lot of trash.  
(B) to hear lectures on the environment.  
(C) to spend more money than other travelers.  
(D) to carry their own food.

Questions 5-8 refer to the following passage.

Meetings can waste a great deal of time. But you can make your meeting run more smoothly by following a few simple rules. First, have an agenda. This will help keep you focused on what is important. Next, decide who needs to be involved. More people means less efficient discussion. Finally, keep the discussion moving. Thank each speaker as he or she finishes and move on to the next speaker. This encourages people to make their comments brief. And don't forget: What happens after a meeting is more important than what happens during the meeting. The skills used then are more professional and less procedural. So no matter how well you run a meeting, it is the work that gets done after the meeting that is important.

5. What is one way to run a meeting well?
  - (A) Watch how your manager runs meeting.
  - (B) Minimize the number of participants.
  - (C) Let the group make decisions.
  - (D) Let everyone speak
  
6. What is the purpose of a meeting agenda?
  - (A) To keep the speakers organized
  - (B) To allow free discussion
  - (C) To send to others in advance
  - (D) To keep focused on important items
  
7. How should you receive other people's comments at a meeting?
  - (A) Try to keep others from talking.
  - (B) Thank them and move on..
  - (C) Give them as much time as they want.
  - (D) Respond in detail to all comments
  
8. What is the right statement for a meeting?
  - (A) meetings should be held every day.
  - (B) all meetings should be on Monday morning.
  - (C) no one should receive credit for their work
  - (D) the real work is accomplished after the meetings

Questions 9-10 refer to the following passage.

Hollywood is no longer just in California. Today the entertainment industry is finding new homes in Europe, Latin America, and Asia. The American media and communications industries are looking all over the globe for new opportunities. Although many companies are investing in the fast-growing European media industry, many industry executives believe the biggest long-term opportunity is in China and other countries in Southeast Asia. The potential market is huge—over 310 million people in the European community, but over 650 million in the Pacific Rim.

9. Which of the following is the main topic of the article?
- (A) The media industry is expanding to Europe, Latin America, and Asia.
  - (B) China has a big market today.
  - (C) New homes are being built in Europe.
  - (D) There are many opportunities in Hollywood.
10. According to the article, what does “Hollywood” represent?
- (A) All executives
  - (B) American enterprise
  - (C) The media industry
  - (D) Big markets

Questions 11-13 refer to the following passage.

The Information Highway is the road that connects computer users to a large number of on-line services: the Web, electronic mail, public forums, and software, etc. Not long ago, the Information Highway was a new road, with not many users. Now, everyone seems to want to take a drive, with over 30 million households connected worldwide. Not surprisingly, this highway is getting very busy. Traffic jams can cause routers to break down, forcing the system to close down for maintenance and repair. Naturally, “accidents” will happen on these busy roads, causing people to accidentally lose a file. Then, of course, there’s Mr. Cool, with his new broad-band connection, who speeds down the highway faster than most of us can go. But don’t kid yourself; he pays for that speeding.

11. What is this article about?
- (A) Accessing information on computers
  - (B) E-mail
  - (C) Traveling by highway
  - (D) Traffic problems on crowded roads
12. Why would the Information Highway need to be closed?
- (A) There are too many services.
  - (B) There aren’t enough users.
  - (C) There are too many users.
  - (D) There’s a car accident.
13. Who can travel fastest on the highway?
- (A) Someone in a fancy new car
  - (B) Cool people
  - (C) Someone with a broad-band connection
  - (D) The police

Questions 14-18 refer to the following passage.

### Are You the New Target for Hackers?

Is your company a sitting duck for hackers? When did you last change your password? How complete are your security systems? Have you ever been broken into before? According to IANS, the International Association for Network Security, there's a new breed of hacker out there. And, there's a new target. In the past, hackers gained notoriety from breaking into big companies' networks. In fact, the bigger the company, the bigger the success. When hackers broke into Infelmax's notoriously secure system in 1999, they made headline news around the world. The big "successes" came with a major drawback. These headline break-ins came with international teams of investigators and serious criminal charges. Several former hackers are now sitting behind bars or working overtime to pay off hefty fines in penalties and damages.

So, hackers of the new decade have turned to a new target: smaller companies. Smaller companies often spend less on their security systems. If they have never been broken into before, they may be lulled into a feeling of security. They are often lax about changing their password frequently enough. And that spells trouble. Also, a breached system in a smaller company may attract little public attention. Investigations may be brief and superficial, as overloaded investigators pursue bigger problems. But if you do fall victim to hackers, it will definitely attract your attention. These thieves can gain access to your files, destroying, copying, or altering them. They can create havoc with your data. And if they do, you'll surely wish you had changed your password more often.

14. Which is a likely victim for this breed of hackers?

- (A) Large companies
- (B) Small companies
- (C) International companies
- (D) Companies without a security system

15. What might have been one motive for the hackers of Infelmax's network?

- (A) Money
- (B) Power
- (C) Fame
- (D) Fun

16. What has happened to some big-name hackers?

- (A) order
- (B) copies
- (C) destruction
- (D) documents

17. The word *havoc* in line 17 is closest in meaning to

- (A) order
- (B) copies



- (C) confusion
- (D) documents

18. What might help hackers to succeed?
- (A) They've never broken into a company before.
  - (B) They feel secure.
  - (C) Their targeted network is old.
  - (D) Their targets rarely change their passwords.

## Appendix B

### Questionnaire Survey

**Section I:** Please complete the following:

Name: \_\_\_\_\_ Student ID: \_\_\_\_\_

What is your gender? \_\_\_\_\_

What is your age? \_\_\_\_ years

How many years have you been learning English? \_\_\_\_ years

**Section II:** Please circle one of the five possible responses: 1) strongly disagree; 2) disagree; 3) neutral; 4) agree and; 5) strongly agree.

Questions		strongly disagree	disagree	neutral	agree	strongly agree
1	I gained English language skills through the learning process using this instructional approach.	1	2	3	4	5
2	I gained content area knowledge about the topics using this instructional approach.	1	2	3	4	5
3	I learn to make a plan to allow enough time to accomplish the tasks using this instructional approach.	1	2	3	4	5
4	I gained a deeper understanding of the concept when involving in the activities.	1	2	3	4	5
5	I learn research skills using this instructional approach.	1	2	3	4	5
6	Learning English through using this instructional approach was interesting.	1	2	3	4	5
7	The instruction had increased my motivation to learn English.	1	2	3	4	5
8	The approach made English learning meaningful.	1	2	3	4	5
9	The approach gave me opportunities to think.	1	2	3	4	5
10	Overall, I thought that taking part in the activities enhanced my critical thinking ability.	1	2	3	4	5
11	Overall, I thought that taking part in the activities helped me to gain confidence in my own English language ability.	1	2	3	4	5

**Section III:**

How many total hours did you spend locating information?

How many total resources did you use for completing the tasks?

## Appendix C

### Questionnaire Survey Chinese Version

### 問卷調查

親愛的同學：

感謝您在繁忙的課業當中撥冗為我的研究填寫這份問卷，本問卷所得資料純供學術研究之用，請您安心填寫。若您想要了解此研究的結果，歡迎來函索取。誠摯感謝您的協助。

博士候選人：呂欣玲

Email:

hsinlinlu@gmail.com

#### 一、基本資料

性別：( )男( )女

姓名：\_\_\_\_\_

年齡：\_\_\_\_\_

學習英文的時間：\_\_\_\_\_年

#### 二. 請依照您的看法, 在下列五點量表中, 圈選適當的回答

您認為在學習英語過程中, 此教學法(作業)使我						
1	英語技能進步。	很不同意	不同意	無意見	同意	非常同意
2	獲得主題內容方面的知識。	很不同意	不同意	無意見	同意	非常同意
3	學會事先計畫運用時間的能力。	很不同意	不同意	無意見	同意	非常同意
4	對課程有更深的整體概念。	很不同意	不同意	無意見	同意	非常同意
5	學會搜尋資料技巧。	很不同意	不同意	無意見	同意	非常同意
6	感覺學習英語變有趣。	很不同意	不同意	無意見	同意	非常同意
7	提高對英語學習的興趣	很不同意	不同意	無意見	同意	非常同意
8	感覺英語學習有意義	很不同意	不同意	無意見	同意	非常同意
9	有機會思考所學	很不同意	不同意	無意見	同意	非常同意
10	增進批判思考能力	很不同意	不同意	無意見	同意	非常同意
11	對自己的英語能力更有自信	很不同意	不同意	無意見	同意	非常同意

為了完成作業總共花了你多少時間找尋資料? \_\_\_\_\_小時

你總共使用了幾個資料來源來完成作業? \_\_\_\_\_個

Appendix D

Authors' Agreement Form of CTT-II

「 批判思考測驗第二級」使用同意書

使用者：Hsin-lin Lu

單位：University of Kansas

研究題目：Enriching Critical Thinking and Language Learning with Educational  
Digital Library

電話：1-785-3316036

電子信箱：hsinlinlu@gmail.com

日期：西元 2011 年 11 月 8 日

茲同意\_Hsin-lin Lu\_使用本測驗。編製者：



日期：西元 2011 年 11 月 8 日

## Appendix E

### Human Subjects Committee Approval



11/23/2011  
HSCL #19737

Hsin-lin Lu  
1745 Bagley Dr. #2  
Lawrence, KS 66044

The Human Subjects Committee Lawrence reviewed your research update application for project

19737 Lu / Aust (C & T) Enriching Critical Thinking and Language Learning with Educational Digital Library in an English as a Foreign Language Classroom

and approved this project under the expedited procedure provided in 45 CFR 46.110 (f) (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

The Office for Human Research Protections requires that your consent form must include the note of HSCL approval and expiration date, which has been entered on the consent form sent back to you with this approval.

1. At designated intervals until the project is completed, a Project Status Report must be returned to the HSCL office.
2. Any significant change in the experimental procedure as described should be reviewed by this Committee prior to altering the project.
3. Notify HSCL about any new investigators not named in original application. Note that new investigators must take the online tutorial at [http://www.rcr.ku.edu/hsc/hsp\\_tutorial/000.shtml](http://www.rcr.ku.edu/hsc/hsp_tutorial/000.shtml).
4. Any injury to a subject because of the research procedure must be reported to the Committee immediately.
5. When signed consent documents are required, the primary investigator must retain the signed consent documents for at least three years past completion of the research activity. If you use a signed consent form, provide a copy of the consent form to subjects at the time of consent.
6. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.

Please inform HSCL when this project is terminated. You must also provide HSCL with an annual status report to maintain HSCL approval. Unless renewed, approval lapses one year after approval date. If your project receives funding which requests an annual update approval, you must request this from HSCL one month prior to the annual update. Thanks for your cooperation. If you have any questions, please contact me.

Sincerely,

A handwritten signature in black ink, appearing to read 'Jan Butin'. Below the signature is the printed name and title: 'Jan Butin, HSCL Interim Coordinator, University of Kansas'.

Jan Butin  
HSCL Interim Coordinator  
University of Kansas

cc: Ronald Aust

## Appendix F

### Informed Consent Statement

#### NAME OF THE STUDY

Enriching critical thinking and language learning with educational digital libraries

#### INTRODUCTION

You are invited to participate in a research project conducted by The Department of Curriculum & Teaching at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

#### PURPOSE OF THE STUDY

The purpose of this study is twofold: first, to investigate if an organized educational digital library can be a valuable technological tool to support and improve EFL student's critical thinking skills, and second, to explore if critical thinking skills can be taught and developed along with improving English language skills, with a special focus on English as a foreign language education.

#### PROCEDURES

If you agree to take part in this study, you will be asked to follow the six-step information search process to complete three assignments. (The entire class will be involved in this project as a regular class activity). A critical thinking test and a reading comprehension test will be administered before and after the intervention. The critical thinking test will take about 30 minutes. The reading comprehension test will take about 20 minutes. Demographic and questionnaires survey will be administered at the end.

#### RISKS

This study involves no risks to your physical or mental health beyond those encountered in the normal course of everyday life.

#### BENEFITS

Although participation may not directly benefit you, your participation in this study may be educationally beneficial for you. The activity may provide you with additional opportunities to practice and enhance your critical thinking and reading comprehension skills.

## PAYMENT TO PARTICIPANTS

Your participation in this study is voluntary; you will not be paid for your participation by the researcher or any other organization

## PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless required by law or you give written permission. Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

## REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

## CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to principal investigator, Hsin-lin Lu by email: [hsinlinlu@ku.edu](mailto:hsinlinlu@ku.edu) or the faculty supervisor, Dr. Ron Aust, email: [aust@ku.edu](mailto:aust@ku.edu). We appreciate your cooperation. If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

## QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher listed at the end of this consent form.

## PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus





## Appendix G

### Informed Consent Statement Chinese Version

#### 同意書

親愛的學生:

我是堪薩斯大學教育學院的博士研究生. 感謝您在繁忙的課業當中撥冗參與這項研究. 本人目前正在研究探討『教育數位典藏(educational digital libraries)』對促進台灣大學生之英語閱讀理解與批判性思考技能之成效。為了完成這項有關科技融入英語教育的研究, 本人需要您的合作與參與.

以上的資料提供給您是否願意參與這個研究, 你可以拒絕參與這項研究, 但您的參與對這項研究是非常重要的並且對科技融入英語教學將有所貢獻. 如果您願意參與這項研究, 請在下面的同意書上, 簽上你的名字. 如你有任何疑問, 可連絡我的指導教授, Dr. Ron Aust at (785)864-3466 or aust@ku.edu 或致電我本人呂欣玲 at (785)331-6036 or hsinlinlu@ku.edu 或寫信到 Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, Phone: (785)864-7429, Email: mdenning@ku.edu or dhann@ku.edu

敬祝各位身體健康、學業進步!

請簽名: \_\_\_\_\_ 日期: \_\_\_\_\_

研究者: 呂欣玲  
堪薩斯大學  
教育學院  
博士候選人  
1745 Bagley Dr. #2 Lawrence, KS 66045  
電話: 785-331-6036  
E-mail: hsinlinlu@ku.edu

## Appendix H

### The Homepage of National Science Digital Library

