

THE ROLE OF CRITICAL THINKING SKILLS IN THE TEACHING OF  
COMPUTER LITERACY IN THE COMMUNITY COLLEGE

by

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This thesis is submitted in partial fulfillment of the requirements for the degree of  
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## ABSTRACT

This study examined the effect of infusing Richard Paul's critical thinking model into a computer literacy course. It studied community college students' abilities to perform better in the discipline of computer literacy, as well as achieve an improved knowledge of a disposition toward critical thinking when compared to a control group not receiving the critical thinking treatment.

Six sections of the *Introduction to Computers* class were randomly selected for this one-semester quasi experimental study, with three randomly placed in the experimental group and the other three in the control group. The only instructional difference between the groups was the infusion of critical thinking into the experimental group (n = 46). The control group (n = 46) was taught without this approach.

Both groups were given a pre- and post-test measure of both critical thinking and computer literacy during the course of the study. While the quantitative findings showed no significant differences between the groups in understanding of the critical thinking model used in the study during the course of one semester, statistically significant improvements in computer literacy were noted in the experimental group.

Three major conclusions emerged from this study: (1.) When infusing critical thinking into the curriculum, community college students are able to significantly improve computer literacy skills in a single course. (2.) By making expectations clear for students, explicitly teaching the model of critical thinking, and promoting active learning through the interaction of the material utilizing critical thinking concepts, students were better able to learn computer literacy. (3.) Infusing Richard Paul's model into a computer literacy class over a single semester may have no effect on students' abilities to learn the model of critical thinking itself, at least as assessed by the test instrument used in this study. Several potential explanations for this finding are discussed herein.

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## **CHAPTER 1**

### **INTRODUCTION**

Over the last fifteen to twenty years, computer technology has reshaped virtually every aspect of the way we live, learn, do business, and interact socially, and this technology is and will continue to rapidly evolve in ways that we can't even anticipate. Most jobs now require at least some level of interaction and expertise with computer technology. These skills are intricately woven into nearly every industry, business and academic enterprise. Consequently, community colleges should "no longer limit their focus to the traditional three Rs of readiness – reading, writing and arithmetic – but should take into consideration the technology readiness levels as well" (Ratliff, 2009).

Because computer technology has been accessible and utilized by the general public over the last two decades or so, and computers are frequently used by students coming up through the K-12 system, there often is a mistaken notion that students entering post-secondary education have the required computer skills to be successful in higher level academics. This perception is often held not only by college administration and faculty, but also by the students themselves (Grant, Malloy, & Murphy, 2009).

However subsequent assessment or simple inability to perform at the minimum levels more often than not demonstrates otherwise. While these students may have been

using computers in a limited fashion throughout their K-12 experience, many don't possess the breadth or depth of computer literacy or proficiency needed to be truly successful either academically or within the workforce.

For example, in his 2011 article in *Inside Higher Ed* entitled "What Students Don't Know," Steve Kolowich "explodes the myth of the digital native" (subheading, second section). The article cites the ERIAL (Ethnographic Research in Illinois Academic Libraries) project – a series of studies conducted at Illinois Wesleyan, DePaul University, and Northeastern Illinois University, and the University of Illinois's Chicago and Springfield campuses – in which the libraries enlisted two anthropologists, along with their own staff members, to collect data using open-ended interviews and direct observation, among other methods.

The findings were alarming. In this age of information, students' ability to research, access, assess, and organize data were worse than expected. At Illinois Wesleyan University, "The majority of students – of all levels – exhibited significant difficulties that ranged across nearly every aspect of the search process," according to researchers there. They tended to overuse Google and misuse scholarly databases. They preferred simple database searches to other methods of discovery, but generally exhibited "a lack of understanding of search logic that often hindered their ability to find good sources" (Kolowich, 2011, para. 8).

During the interviews, students mentioned Google more than twice as many times as any other database. The predominance of Google in student research is well-known, but the Illinois researchers found something they did not expect: students were not very good at using Google. They lacked an understanding of the underlying logic

regarding how the search engine organizes and displays its results. Consequently, the students did not know how to critically evaluate the sources the search engine was displaying (Kolowich, 2011, section 2 para. 3).

Researchers said they were surprised by “the extent to which students appeared to lack even some of the most basic information literacy skills that we assumed they would have mastered in high school.” Even students who were high performers in high school lacked these skills. “In other words: Today’s college students might have grown up with the language of the information age, but they do not necessarily know the grammar” (Kolowich, 2011, section 2 para. 4).

Furthermore, students themselves seem unaware that they lack the true computer literacy skills to truly be successful academically and in the workplace. In 2010, Washtenaw Community College in Ann Arbor, Michigan, implemented mandatory computer literacy classes as a requirement for all degree programs. Many students oppose the class’ mandatory status; however, administrators contend that the “classes are essential in order to maintain high educational standards amidst technological advancements in education” (Heddon, 2011, para. 1).

Along with the annoyance many students share for the newly mandatory status of the requirement, some claim the training is unnecessary and redundant. “We had this all through high school,” said Genevieve Harwood, an 18-year-old resident of Ypsilanti. “We don’t need these classes” (Heddon, 2011, para. 8).

And yet a teaching assistant working in the CIS classes, Mohamed Nuh, has first-hand experience with students’ misplaced technology over-confidence and believes it will have a damaging effect on their future success.

“They all know how to use Facebook, but they don’t know computers,” Nuh said. “If you don’t how to use it, you will struggle in the workplace.” Nuh believes the program should “be required across the board to ensure its success” (Heddon, 2011, para. 15-16).

With the pervasiveness of computer technology in our society, it is easy to understand why so many students entering college today would consider themselves computer literate. “Most of these students grew up with computers in their homes, and most of their computers had Internet connections....In addition, many of these students have had some experience with computer applications such as word processors, spreadsheets and presentation software since grade school” (Easton, Easton, & Addo, 2011, p. 39).

This generation of students has also grown up with exposure to, “perhaps overexposure, to tightly-coupled technologies and activities such as cell phones, instant messaging, downloading music and computer gaming. The Internet, however, has arguably advanced the digital generation’s concept of computer literacy more than any other technology” (Easton, Easton, & Addo, 2011, p.39).

The computer-related skills acquired by many students prior to formal post-secondary coursework are simply inadequate with regards to the computer skill sets expected in their college coursework or in the workplace. As a result, “many schools are requiring some type of introductory computer course of their students to ensure their computer literacy, computer competency, or similar term, broadly construed as a measure of one’s aptitude and proficiency with computer and information technology” (Easton, Easton, & Addo, 2011, p.39).



For purposes of this study, there is a distinction drawn between what constitutes computer literacy and what is meant by computer proficiency. According to Childers (2003), “computer proficiency should describe the skills needed to do whatever tasks are necessary on the computer. Proficiency is not literacy, but the ability to do things based on rote memorization or using very little adaptation” (p.102).

Alternatively, computer literacy goes a step or two beyond mere memorization and constitutes a level of understanding that allows students to be both proficient at the tasks they currently know how to perform, but also extend that knowledge by increasing this understanding through an ability to adapt. This capacity includes “being able to solve and avoid problems, adapt to new situations, keep information organized and communicate effectively with other computer literate people” (Computer Literacy USA, 2012).

A fundamental ingredient to this ability to extend knowledge and adapt to unfamiliar tasks is solid critical thinking skills. In fact, critical thinking has been called one of the most important attributes for success in the 21st century (Huitt, 1998, Summary section, para. 1). Rudd (2007) argued that “students must learn thinking and reasoning skills to reach their fullest potential in today’s society. If we are to prepare students for entry and advancement in careers ... we must commit to developing problem solving and decision making through teaching critical thinking skills and developing the dispositions necessary to think critically” (p.46) . Furthermore, Paul & Elder (2009) contend that “in a world of accelerating change, intensifying complexity and increasing interdependence, critical thinking is now a requirement for economic and social survival” (back cover).

Attempts to define critical thinking and refine how it is taught have existed for over 2000 years. Socrates began this approach to learning when he established the importance of asking probing questions. During the 20th century, many writers have contributed to the understanding and theory of critical thinking including Brookfield, Ennis, McPeck, Paul, and Watson & Glaser (for a detailed discussion of the history and evolution of these definitions and approaches, please see the literature review in this dissertation).

Halpern (1997) in her book, *Critical Thinking Across the Curriculum*, provides us with a simple yet comprehensive definition:

Critical thinking is the use of those cognitive skills or strategies that increase the probability of a desirable outcome. It is used to describe thinking that is purposeful, reasoned, and goal directed—the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions when the thinker is using skills that are thoughtful and effective for the particular context and type of thinking task (p. 4).

Halpern, in this definition, speaks to the importance of a critical thinker to have both the appropriate “skills and strategies” as well as the inclination to use them — “purposeful” and “goal directed.”

Richard Paul (Foundation for Critical Thinking, 2012) also speaks to this dual nature when defining critical thinking. He addresses both the necessary skills as well as the disposition to use them when he says, “Critical thinking can be seen as having two components: 1) a set of information and belief-generating and processing skills, and 2)

the habit, based on intellectual commitment, of using those skills to guide behavior” (Defining critical thinking section, para.5).

Some consensus in defining critical thinking was achieved when a multidisciplinary committee of forty-six published critical thinking experts from philosophy, education, and psychology, including Robert Ennis, Stephen Norris, and Richard Paul (Facione, 2011) was assembled and conducted a Delphi research project leading to the development of a consensus definition and conceptualization of critical thinking and its core cognitive skills and affective dispositions. The cognitive skills that the experts agreed to as being at the very core of critical thinking were interpretation, analysis, evaluation, inference, explanation, and self-regulation. Furthermore, the final definition reached by the committee was that the ideal critical thinker is

habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. (p. 26)

It is perhaps Richard Paul (1993) who sums it up best by saying that critical thinking is “the art of thinking about your thinking, while you’re thinking, in order to make your thinking better: more clear, more accurate, more defensible” (p. 526). Inherent in this definition, while perhaps not as explicit as others, is again both the skills to think

critically—‘make your thinking better’—as well as the disposition to use them—  
‘thinking about your thinking, while you’re thinking.’

However, these skills and dispositions also appear to be greatly lacking in many if not most incoming community college freshmen, and therefore should be incorporated into the curriculum at every level. According to Lorenzo and Dziuban in *Ensuring the Net Generation Is Net Savvy* (2006), “How much one learns is strongly correlated with one’s ability to think critically. Having strong critical thinking skills is an important element of being information literate” (p.9).

In *Defining a 21<sup>st</sup> Century Education*, Jerald (2009) says, “Employers rank critical thinking/problem solving as the number one competency they expect to become more important for new entrants over the next five years.” In addition, because of the demand for higher level skills of many jobs due to technology and the flattening of corporate structures, such competencies are no longer only necessary for college-educated employees in white collar professions. Nearly 60 percent of employers rate critical thinking and problem solving as “very important” for graduates entering the workforce, yet 70 percent of employers rated such entrants as “deficient” in that area (Jerald, 2009).

Consequently, if community colleges and educational institutions in general are to successfully prepare students for both future learning as well as workplace productivity, they must take seriously this current lack of computer skills and critical thinking preparedness evident in the majority of incoming freshman. They must respond by teaching computer literacy as a core curriculum requirement and by incorporating critical thinking throughout the college experience.

## Statement of Problem

Each new generation comes to college with a unique set of characteristics that sets them apart from those that came before them. Today's generation of students, commonly known as the Millennial generation, were born after 1982, and according to Monoco & Martin (2007), this group "is the largest and most diverse generation to ever attend college." Furthermore, significant characteristics that distinguish this generation are

- Lack of professional boundaries influenced by socialization
- A need to have immediate feedback
- A sense of entitlement
- Lack of critical thinking skills
- Unrealistic expectations
- High level of parental involvement
- An expected "how to" guide to succeed in and out of the classroom
- A desire to spend less time on tasks and reach success with little effort

In *Teaching Millennials, Our Newest Cultural Cohort*, Angela McGlynn (2005) describes a generation that

- Gravitates toward group activity
- Spends more time doing homework and housework and less time watching television
- Believes that it's "cool" to be smart and are fascinated by new technologies

- Are both racially and ethnically diverse
- Want to learn by working collaboratively; many of them enjoy the activity of teamwork
- Have a preference to learn in their own time and on their own terms
- Seem to appreciate structured activities that permit creativity
- Want to be involved with "real life" issues that matter to them.
- Enjoy using technology.

Interestingly, there is research to suggest that the increased use of technology by this generation of students has actually led to a decline in critical thinking ability. According to research by Patricia Greenfield, UCLA distinguished professor of psychology and director of the Children's Digital Media Center, Los Angeles, "as technology has played a bigger role in our lives, our skills in critical thinking and analysis have declined, while our visual skills have improved" (University of California – Los Angeles, 2009, para.1) . Greenfield analyzed more than 50 studies on learning and technology, including research on multi-tasking and the use of computers, the Internet and video games and discovered that learners have changed as a result of their exposure to technology (para.2).

Of particular note is the movement away from print media toward visual media. "Studies show that reading develops imagination, induction, reflection and critical thinking, as well as vocabulary," Greenfield said. "Reading for pleasure is the key to developing these skills. Students today have more visual literacy and less print literacy. Many students do not read for pleasure and have not for decades" (para. 9).

Yet other experts believe it is premature to make a final judgment on how

technology is impacting critical thinking. “While it’s tempting to view computers, video games, and the Internet in a monolithic good or bad way, the reality is that they may be both good and bad, and different technologies, systems, and uses yield entirely different results” (Greengard, 2009, p.18). The Internet and even video games have the ability, when used correctly, to actually improve critical thinking skills and enhance learning.

Michael Bugeja, director of the Greenlee School of Journalism and Communication at Iowa State University of Science and Technology, says: “Critical thinking can be accelerated multifold by the right technology.” On the other hand, “The technology distraction level is accelerating to the point where thinking deeply is difficult” (Greengard, 2009, p.18).

Millennial students need to be actively engaged with the material we are trying to teach (Pinder-Grover & Groscurth, 2009, p.3). Research from cognitive psychology demonstrates that active engagement promotes deeper levels of processing and learning because it creates stronger connections and facilitates long-term memory through a process known as *elaborative rehearsal*—a memory process that involves the use of meaning rather than rote learning (McGlynn, 2005, Section 4, para. 2).

According to McGlynn, “The use of examples which students can relate to and asking students to develop their own examples are ways to create meaning between students' life experience and the material which we want them to be learning” (McGlynn, 2005, Section 4, para. 2). This student-centered approach empowers students, helping them to build on what they already know.

In addition, “part of the process of getting students to become critical thinkers involves getting them to practice meta-cognition; that is, they must become aware of not

only what they are thinking but also how they are thinking” (McGlynn, 2005, Section 4, para. 4).

The challenge in teaching this generation of students is finding the right mix of strategies that will take advantage of their natural characteristics while at the same time improve their deficiencies. Further, while technology can be part of this ideal mix, it must be used appropriately to enhance learning and not detract from it.

## **Background**

The impetus for this study originated out of the intentions of a small rural community college to implement computer literacy as a core graduation requirement. Specifically, this institution believes graduates should “understand major computer applications including the ethics involved... [and be able to]...apply this knowledge by using a hands-on approach.” In essence what they are defining here is both computer proficiency and literacy (Southwestern Michigan College, 2012, p. 4).

The college uses Certiport’s Internet and Computing Core Certification (IC<sup>3</sup>) examinations as a way for students to demonstrate competency. The IC<sup>3</sup> certification is awarded to those individuals that take and are able to pass three separate exams, titled Computing Fundamentals, Key Applications, and Living Online. Each exam has a 45 minute time limit and consists of 45 multiple choice, matching, and “hands on” performance-based questions.

According to the Certiport (2012), the three IC<sup>3</sup> exams have the following objectives:

**Computing Fundamentals** – “The Computing Fundamentals examination covers a foundational understanding of computer hardware, software, operating systems,



peripherals, and troubleshooting to help students get the most value and impact from computer technology.” The specific expectations for this exam include:

- Identify types of computers, how they process information, and the purpose and function of different hardware components
- Identify how to maintain computer equipment and solve common problems relating to computer hardware
- Identify how software and hardware work together to perform computing tasks and how software is distributed and upgraded
- Identify different types of application software and general concepts relating to application software categories
- Identify what an operating system is and how it works, and solve common problems related to operating systems
- Use an operating system to manipulate a computer’s desktop, files and disks
- Identify how to change system settings, install and remove software

**Key Applications** – “The Key Applications examination covers popular word processing, spreadsheet and presentation applications and the common features of all applications”. The specific expectations for this exam include:

- Be able to start and exit an application, identify and modify interface elements and utilize sources of online help
- Perform common file-management functions
- Perform common editing and formatting functions
- Perform common printing/outputting functions
- Perform Word Processing functions

- Be able to format text and documents including the ability to use automatic formatting tools
- Be able to use word-processing tools to automate processes such as document review, security and collaboration
- Perform Spreadsheet functions
  - Be able to modify worksheet data, structure and formatting
  - Be able to sort data, manipulate data using formulas and functions and create simple charts
- Perform Presentation functions
  - Be able to create and format simple presentations

**Living Online** – “The Living Online examination covers skills for working in an Internet or networked environment and maximizing your communication, education, collaboration and social interaction in a safe and ethical way.” The specific expectations for this exam include:

- Identify network fundamentals and the benefits and risks of network computing
- Identify different types of electronic communication/collaboration and how they work
- Identify how to use an electronic mail application
- Identify the appropriate use of different types of communication/ collaboration tools and the “rules of the road” regarding online communication (“netiquette”)
- Identify information about the Internet, the World Wide Web and Web sites and be able to use a Web browsing application

- Understand how content is created, located and evaluated on the World Wide Web
- Identify how computers are used in different areas of work, school and home
- Identify the risks of using computer hardware and software and how to use computers and the Internet safely, ethically and legally

Certiport's IC<sup>3</sup> exams offer the breadth and depth of subject matter, and incorporate the problem solving component necessary for a true test of critical thinking. This is why the college chose to adopt them as the cornerstone of their computer literacy core requirement; doing so, however, has led to certain problems.

As part of the critical thinking core competency, the ISYS 110 course, "Introduction to Computers," is a required course preparing students to take the IC<sup>3</sup> certification examinations. Originally the ISYS 110 course was structured in such a way that a student could pass only if he or she achieved certification level scores on all three IC<sup>3</sup> exams (a score of 710, 680, and 660 out of a possible 1000 points for each exam respectively).

When the computer literacy requirement, and thus the ISYS 110 course were first introduced, approximately 50% of students enrolled in the course were failing to achieve the required standard, and thus were not able to complete a major graduation requirement. Consequently, grading standards for the course were restructured to allow a student to pass the class without achieving certification levels on all three exams. This level of performance does not certify students by Certiport's standards, but this does meet the graduation core competency.

This coupled with new homework requirements and a modular approach to teaching each section has improved pass rates to approximately 75% (when adjusting for students withdrawing from or otherwise not completing the course). The system, however, is still not without its challenges. Even at a 75% pass rates, a minimum of 25% of students (more when considering those that dropped out of the required course) have essentially been barred from successfully completing their degree requirements. In fact, the college has identified this as one of three courses standing in the way of completion.

In an attempt to identify what factors were preventing student success in the ISYS 110 class, this researcher surveyed instructors currently teaching the course (see Appendix A). Results of the survey indicated that while instructors believe that the average ISYS 110 student falls somewhere in the middle in terms of being able to read a problem and know how to attack it (2.75 on a 5-point scale), bringing knowledge to bear on a problem (2.5 on a 5-point scale), and trusting in their own reasoning (2.75 on a 5-point scale), instructors felt that students were less skilled in systematic problem solving (2 on a 5-point scale) and maintaining a critical attitude throughout the problem solving process (1.75 on a 5-point scale).

Furthermore, when asked to rank in order of importance (with 1 being most important and 5 being least) the reasons that they felt students may be unsuccessful in the ISYS 110 course, “poor critical thinking skills” consistently ranked in the top two with an average ranking of 1.75.

Finally, when asked if they believed that teaching students how to think critically could improve their performance in ISYS 110, all the surveyed instructors agreed that it could. Among the comments as to why included the following:

- “Critical thinking can enable students to form sound beliefs and judgments, and in doing so, formulate a basis for rationalizing and reasoning what needs to be done step-by-step.”
- “The certification exams require a level of critical thinking and reasoning skills that students don’t currently have.”
- “Thinking critically is fundamental to any learning process.”
- “I believe most of the students enter ISYS 110 thinking that they should and can memorize the answers to the practice tests instead of thinking through the questions. They want the answers to the Certification tests to be handed to them – word for word in the book, via lectures or practice tests. They need to understand that the test is about applying their computer/technology knowledge not memorizing.”

What became apparent from these surveys was that a missing component in students’ ability to be successful in this course is their lack of critical thinking skills. The IC<sup>3</sup> exams specifically test for computer literacy, which goes a step or two beyond computer proficiency or merely rote memorization of computer concepts and tasks. True literacy extends that knowledge by increasing this understanding through an ability to adapt, to solve and avoid problems, and adjust to new situations. (Computer Literacy USA, 2012).

While students are learning computer concepts, they are often unable to take what they are learning and apply it to a unique or unfamiliar problem (as they are asked to do on the IC<sup>3</sup> exams). The current curriculum is primarily lecture-based with students

reading textbook material, instructors lecturing in class, and students being required to complete end-of-chapter multiple choice and matching-type homework questions. Students are also able to complete IC<sup>3</sup> “practice tests” that help them to prepare for the types of questions they can expect.

After failing to successfully pass the required exams, the comments and questions that instructors hear from students speak to the frustration students are experiencing. “What should I be studying?” and “I don’t remember seeing any of these questions on the practice test,” or “we didn’t go over any of this stuff in class.” In spite of instructors’ warnings to students that they will be required to take what they learn and apply it to a question or problem they have not encountered before, they still seem intent on preparing for the exams through the more familiar studying approach of rote memorization. It is the intent of this study to see if more actively engaging the students in the learning process by teaching the material using a critical thinking based approach can make a measurable difference in student success.

It seems students’ inability to apply higher order thinking in their academics is not reserved only for computer literacy coursework. Consequently, it is imperative that we find ways to teach these skills across the curriculum to give students, “a fighting chance to compete, to rise to the challenges of the day” (Paul, 1993, p. 5). Computer literacy courses in general are an ideal opportunity to do this as they involve a fair amount of analysis and problem solving.

### **Purpose of Study**

Because of the gap in what students need to know with regards to computer literacy and critical thinking and what they actually do know, the purpose of this study

is to identify any relationship between teaching critical thinking skills and improved student performance in an introductory computer literacy course at a rural community college. In exploring this potential relationship lies the broader implication that deliberately introducing critical thinking into the curriculum of computer literacy courses can improve student outcomes in not only computer classes. Rather this combined achievement in the foundational areas of both computer literacy and critical thinking may potentially lead to better long-term academic success across the curriculum.

### **Research Questions**

1. Will a group of community college students who receive explicit training in computer literacy concepts using a critical thinking approach perform better on computer literacy tests that require the application of analysis and reasoning than a group of similar students not receiving explicit instruction in critical thinking?
2. How can critical thinking skills be infused into computer literacy instruction to best improve student performance in both areas?
3. Can the teaching of computer literacy using a critical thinking approach improve critical thinking skills during a single course over the course of one semester, and, if so, to what degree can this occur?

### **Theoretical Framework**

This study attempts to add to the knowledge of how students learn computer literacy and how such courses can be used to develop students' critical thinking skills by assessing the effectiveness of Richard Paul's model for critical thinking on improving students' critical thinking abilities in computer literacy courses (Foundation for Critical

Thinking, 2012).

Paul is an influential leader in the critical thinking movement. He fights for educational reform that will better address our need for developing critical thinking skills, and he has developed a model for critical thinking that provides a realistic and adaptable approach to meeting these concerns.

Paul's approach to teaching for critical thinking as a general model is applicable to any problem or issue requiring reasoning. It is equally appropriate to issues in both academic disciplines as well as everyday problems. In addition, it can be used by anyone wishing to improve his or her thinking, from primary school students to adult learners.

Prior to the present study, the researcher participated in training in general features of Paul's model by attending a three-day conference presented by the *Foundation for Critical Thinking*. This training included an overview of the model and practice in using the model in classroom discussions and development of course materials. It is a direct result of this training that Paul's model was selected from among several general critical thinking models for investigation in this study because of this researcher's discovery of its rich theoretical foundation, its flexibility and applicability to a wide range of circumstances requiring good reasoning, its limited use of specialized jargon, and its inclusion of standards and dispositions.

The adaptability of the Paul model is one of its most exceptional characteristics. The only significant change that is required is a change in teaching methodology. Reed and Kromrey (2001) used Paul's (1993) model for critical thinking in a community college history course. They found that there was significant student improvement in historical thinking as well as general critical thinking skills. Results from this study



successfully demonstrate that the development of critical thinking skills as well as core subject matter learning can be positively influenced by the infusion of critical thinking teaching methods into the curriculum. In the current study, critical thinking teaching methods were used within the context of studying computer literacy to see if significant improvements could be made in both critical thinking skills as well as core content computer literacy skills.

Paul's approach seems especially suited to analyzing and solving computer literacy problems, especially in the context of the Computer Literacy USA (2012) definition of computer literacy that extends the definition of general computer proficiency to also include "being able to solve and avoid problems [and] adapt to new situations." In addition, the newest extension of computer literacy, information literacy also seems well suited to Paul's model incorporating "understanding [of] the underlying concepts of technology and applying problem-solving and critical thinking to using technology" (National Research Council, 1999).

If such a general model can help students improve their abilities to think within this computer literacy course and at the same time to think more effectively in other coursework as well as in their everyday reasoning, it warrants a wider integration into the educational curriculum.

### **Other Theoretical Models of Critical Thinking**

While Richard Paul's model was selected for use in this study, several other general critical thinking models were considered. For example, an examination of critical thinking theory would be remiss without consideration of Benjamin Bloom's (1956) work.

### ***Benjamin Bloom***

Bloom's taxonomy identifies six levels of learning through which a student can progress. The six levels, most often depicted as a hierarchy, are *knowledge*, *comprehension*, *application*, *analysis*, *synthesis*, and *evaluation* (as cited in Whitely, 2006, p. 66).

1. The *knowledge* level focuses on whether the learner can recall, recognize, or identify specific information [e.g., identify the major components of a computer system].
2. The *comprehension* level focuses on whether the learner understands the meaning of a content area [e.g., explain the purpose of each component of the computer system].
3. The *application* level focuses on whether the learner can apply a content area [e.g., figure out how many megabytes of RAM are needed to run the listed software].
4. The *analysis* level focuses on whether the learner can see relationships in the content and can separate the material into its various parts [e.g., from a theoretical and application perspective, explain the nature of the problems of the computer system as described in the case study].
5. The *synthesis* level focuses on whether the learner can establish new relationships [e.g., suggest alternative solutions to solve the identified problem in a case study].

6. The *evaluation* level focuses on whether the learner can evaluate alternatives and arrive at an appropriate solution based on a reasoned assessment of the situation [i.e., recommend the best solution to the problem in the case study].

In Bloom's taxonomy, *knowledge*, *comprehension*, and *application* are considered to represent lower-order learning and *analysis*, *synthesis*, and *evaluation* are considered to characterize higher-order learning. Not surprisingly, higher-order learning is considered to be much more difficult to achieve than lower-order learning, particularly because it involves critical thinking, which requires one to go beyond just the basic facts, and to use "reasoned thinking to gain the insight required to deal with the situation at hand" (Whitely, 2006, p. 66).

While Bloom's classification of learning is the foundation for much of the theoretical frameworks for thinking that followed, over the last fifty years, a rapidly expanding knowledge base for richer and more diverse models for critical thinking has emerged, many of which provide more robust frameworks for critical thinking pedagogy that have given application to Bloom's work.

### ***Edward de Bono***

Edward de Bono is regarded as another leading authority in the field of critical thinking, in particular creative thinking, innovation and the direct teaching of thinking as a skill. He is also well known for his development of the "Six Thinking Hats" technique and the "Direct Attention Thinking Tools." According to the de Bono Group web site (2012), "Six Thinking Hats<sup>®</sup> is a simple, effective parallel thinking process that helps people be more productive, focused, and mindfully involved." It separates thinking into

six clear functions and roles. Each thinking role is identified with a colored symbolic “thinking hat.” By mentally wearing and switching ‘hats,’ one can easily focus or redirect thinking.

- The White Hat calls for information known or needed.
- The Yellow Hat symbolizes brightness and optimism, explores the positives, and probes for value and benefit.
- The Black Hat acts as judgment – the devil's advocate or why something may not work and spots the difficulties, the dangers, and where things might go wrong.
- The Red Hat signifies feelings, hunches and intuition, expresses emotions and feelings, and shares fears, likes, dislikes, loves, and hates.
- The Green Hat focuses on creativity—the possibilities, alternatives, and new ideas and provides an opportunity to express new concepts and new perceptions.
- The Blue Hat manages the thinking process and acts as the control mechanism ensuring that the Six Thinking Hats<sup>®</sup> guidelines are observed.

When done in a group, everybody should wear the same hat at the same time. The principle behind the “Six Thinking Hats” is parallel thinking which ensures that all the people in a group are focused on and thinking about the same subject at the same time. While de Bono’s “Six Thinking Hats” model has much potential value, it is best suited for work with younger students and those working in groups, so it is not the ideal model for teaching critical thinking in a community college computer literacy course.

## ***Vincent Ruggiero***

Vincent Ruggiero is yet another leading theorist in the field of critical thinking providing special emphasis on the aspect of critical thinking associated with problem solving.

He defines thinking as, “any mental activity that helps formulate or solve a problem, make a decision, or fulfill a desire to understand. It is a searching for answers, a reaching for meaning” (Ruggiero, 2009, p.4). Further, he specifies that the process of thinking is a “purposeful mental activity over which we exercise some control. *Control* is the key word (p.4).” Ruggiero likens the process of thinking to that of driving a car, which is only in control when it is being properly steered.

Ruggiero also distinguishes between good and poor problem solvers (p. 12).

### **Good Problem Solvers**

- Read a problem and decide how to begin attacking it
- Bring their knowledge to bear on a problem
- Go about solving a problem systematically—for example, trying to simplify it, puzzling out key terms, or breaking the problem into sub-problems
- Tend to trust their reasoning and to have confidence in themselves
- Maintain a critical attitude throughout the problem-solving process

### **Poor Problem Solvers**

- Cannot settle on a way to begin.
- Convince themselves they lack sufficient knowledge (even when that is not the case)

- Plunge in, jumping haphazardly from one part of the problem to another, trying to justify first impressions instead of testing them
- Tend to distrust their reasoning and to lack confidence in themselves
- Lack a critical attitude and take too much for granted

Finally Ruggiero associates the creative process with critical thinking, stating, “there are two phases to thinking: the *creative* phase, in which ideas are produced, and the *critical* phase, in which they are evaluated (p. 185).” His model outlines a series of stages for the creative phase (pp. 105-106):

- The First Stage: Searching for Challenges
- The Second Stage: Expressing the Problem or Issue
- The Third Stage: Investigating the Problem or Issue
- The Fourth Stage: Producing Ideas

Ruggiero then goes on to specify the stages of the critical phase of thinking:

- Refine your Solution to the Problem (pp. 198 – 200)
  - Step 1: Work out the Details
  - Step 2: Find Imperfections and Complications
  - Step 3: Make Improvements
- Evaluate the Arguments on the Issue (p. 219)
  - State the argument fully, as clearly as possible
  - Examine each part of the argument for errors affecting truth

- Examine the argument for validity errors; that is, consider the reasoning that links conclusions to premises
- If one or more errors are found, revise the argument to eliminate them
- Refine the Resolution of the Issue (p. 229)
  - Step 1: Decide What Action Should be Taken
  - Step 2: Recognize and Overcome Difficulties

While Ruggiero's model provides an effective approach to problem-solving, this skill is only one of several that are necessary for computer literacy. As a result, it was deemed not comprehensive enough to serve as the model for this study.

### ***Diane Halpern***

Diane Halpern (1998) proposes yet another model for the teaching of critical thinking. In *Teaching Critical Thinking for Transfer Across Domains*, she describes a model made up of four components. In the first two, Halpern outlines what to teach to improve critical thinking. In the other two, she presents a procedure for instruction: a way to organize the teaching so that what is taught is really learned and applied when the situation at hand warrants it. Following is a brief look at each of these components:

1. Instruction in and practice with the critical thinking skills. Halpern proposes the following category of skills for guiding instruction (p.452):
  - a. verbal reasoning
  - b. analysis of arguments
  - c. confirmation of hypothesis

- d. probability and uncertainty
  - e. decision making and problem solving
2. Disposition to engage in a difficult type of thinking and its learning. It is important to distinguish between the capacity for thinking critically and the disposition to apply such skills. Some people may have great skills and yet lack the disposition to apply them and, hence, the dispositional component is very important. Among the dispositions pointed out by Halpern are the following (p. 452):
- a. the disposition to become committed and persist in a complex task
  - b. a common tendency to forge plans and suppress impulsive activity
  - c. a disposition of flexibility and impartiality
  - d. the disposition to abandon unproductive strategies, etc.
3. The structural component to promote transfer. The final aim of teaching critical thinking is not only that students be able to understand and use the skills or strategies taught, but also that they become able to use them in new situations when necessary. Halpern suggests that learning should be organized so that it will not depend on content in order to facilitate the recovery of skills. With this in mind, she offers the following suggestions (pp. 453-454):
- a. make the structural aspects of problems and arguments as relevant as possible so that learning them will not depend on the content
  - b. encourage practice with different classes of examples; have the students do exercises and tasks similar to those found in the real world



- c. offer corrective feedback to develop the habit of “becoming aware spontaneously”
  - d. promote effective elaboration of information in memory, for example, by the use of organization so that interconnected knowledge structures can be developed (the use of reflexive questions is a technique that can help achieve this) that will be similar to those found in daily contexts
4. The last of the four components is meta-cognition, in which it is suggested that students should be faced with a series of issues to help them to convert implicit cognitive processes into explicit ones (p.454).

Halpern’s theoretical framework is observably comprehensive, but its complexity makes it difficult to apply to a single course in a meaningful way. One could see how the framework could inform the development of an all-inclusive model for critical thinking across the curriculum, but for purposes of this study, the flexibility of Richard Paul’s model was more appropriate.

### ***Stephen Brookfield***

Stephen Brookfield (1987) provides us with yet another robust model. He outlines four major components of critical thinking (pp.7-9):

1. Identifying and challenging assumptions is central to critical thinking
2. Challenging the importance of context is crucial to critical thinking
3. Critical thinkers try to imagine and explore alternatives
4. Imagining and exploring alternatives lead to reflective skepticism

Brookfield (1987) goes on to identify common processes involved in critical thinking (pp.231-233):

1. Processes of critical thinking are person-specific
2. Emotions are central to critical thinking
3. Intrinsic and extrinsic reasons for thinking critically are both important
4. Critical insight often occurs unexpectedly
5. Peer support is crucial to thinking critically

Finally, Brookfield (1987) offers the following regarding facilitating critical thinking (pp. 233-235):

1. There is no standard model of facilitating critical thinking
2. Diversity in methods and materials is necessary
3. Perfection is impossible
4. Learner satisfaction is not the sole aim of critical thinking
5. Risk taking is important

Brookfield's theory is robust and unencumbered by professional jargon, but unlike Richard Paul's model, it does not provide a strong enough application framework for use in this particular study in that it cannot be as easily adapted in both scale and context.

### ***Robert Ennis***

It is Robert Ennis' model that came closest to Paul's model in providing a framework for this study. According to Ennis (2002) the critical thinker:

1. Is open-minded and mindful of alternatives
2. Tries to be well-informed
3. Judges well the credibility of sources
4. Identifies conclusions, reasons, and assumptions

5. Judges well the quality of an argument, including the acceptability of its reasons, assumptions, and evidence
6. Can well develop and defend a reasonable position
7. Asks appropriate clarifying questions
8. Formulates plausible hypotheses; plans experiments well
9. Defines terms in a way appropriate for the context
10. Draws conclusions when warranted, but with caution
11. Integrates all items in this list when deciding what to believe or do

Furthermore, on his web site in a section entitled, *Strategies and Tactics for Teaching Critical Thinking*, Ennis acknowledges that, “The actual teaching of critical thinking is a function of many situation-specific factors: teacher style, teacher interest, teacher knowledge and understanding, class size, cultural and community backgrounds and expectations, student expectations and backgrounds, colleagues’ expectations, recent local events, the amount of time available to teachers after they have done all the other things they have to do, and teacher grasp of critical thinking.”

Consequently, he suggests some “general strategies and tactics gleaned from years of experience, research, and others’ suggestions.”

Those strategies most applicable to this study include:

1. Use a defensible conception of critical thinking with which you feel comfortable.
2. Emphasize alertness for alternative hypotheses, conclusions, explanations, sources of evidence, points of view, plans, etc.

3. Emphasize seeking reasons and evidence. Frequently ask, and invite your students to ask, "Why?" in a non-threatening way.
4. Emphasize their seeing things from others' points of view and being open.
5. Assess (test for) what is important in critical thinking – and do it validly; incorporate the results in the course grades, or other report that matters to the students; and discreetly make sure that students are aware of this incorporation.
6. Students do not need to become subject matter experts before they can start to learn to think critically in a subject. These things can proceed together, each helping the other.
7. In a subject-matter course, the time required for infusion of critical thinking is usually justified, not only for the critical thinking learned, but also for an enhanced understanding of the subject. Note: “Infusion” here refers to the embedding of critical thinking in subject matter instruction that ensures that the principles of critical thinking are explicit, whether stated by students or the teacher. “Immersion” refers to the embedding in which critical thinking principles are not made explicit. Of course some cases lie in between. Infusion is more likely to succeed than immersion.
8. For infusion, arrange it so that either you or the students make explicit the principles of critical thinking involved.
9. Frequently give explicit positive feedback and recognition for efforts and successes in learning or applying critical thinking principles.
10. Give students time to think about questions and situations. If you wait long enough, someone will offer an answer. In other words, provide “wait time.”

11. Be ready to postpone an assignment, if the content of the previous assignment is not understood.
12. Have students work on issues or questions in groups, with each group reporting to the entire class, and each person showing the others what he or she has done. Students are eager to do well in the eyes of their peers (just like us).

While Ennis' model/guidelines came closest to Paul's model in providing a framework for this study, ultimately Paul's model provided both the structure and flexibility needed in this application.

### ***Paul-Elder Model***

Richard Paul's model was co-developed with the help of Linda Elder. The Paul-Elder framework has three components (Paul, R. and Elder, L. (October 2010):

- Eight elements of thought (reasoning)
- Nine intellectual standards that should be applied to the elements of reasoning
- Eight intellectual traits associated with a experienced critical thinker that result from the steady and controlled application of the intellectual standards to the elements of thought

For a more in depth discussion of the Paul-Elder model and its application in this study, please refer to Appendix B and D.

### **Significance of the Study**

This study attempted to identify any potential improvement to student outcomes by deliberately introducing critical thinking concepts into an introductory computer course. Because critical thinking and computer proficiency are both skills that are

increasingly necessary for both academic and workplace success, the findings have the potential to be significant if the research can successfully demonstrate that teaching these components concurrently can increase the abilities in either area.

It paves the way for additional research into how incorporating critical thinking skills into other disciplines utilizing the same model throughout the curriculum may demonstrate similar results and therefore act as a new direction for the way instruction takes place.

### **Limitations**

The study that was carried out was a quasi-experiment using the nonequivalent control group design involving two groups of students in an Introductory Computer Literacy course (control and experimental) who were pre-tested and post-tested. In addition, the experimental group was administered a treatment (instruction in critical thinking). The success of the treatment was determined by comparing the control and experimental group pre- and post-test scores on the *International Critical Thinking Basic Concepts and Understandings Test*, and pre- and post-test scores on the Certiport IC<sup>3</sup> Certification Exams. As such, the following limitations were identified;

1. The subjects in the student assessment were limited to students at a small, rural Midwestern community college who had not yet taken a computer literacy/skills course at the post-secondary level. As such, the findings from this study cannot be generalized to other students of other levels or at other colleges.
2. The subject under study was on critical thinking instruction as it relates to computer literacy and as such, the study findings cannot be generalized to other disciplines in the curriculum.

3. A quasi-experimental design is one that looks a bit like an experimental design but lacks random assignment. Because this study used intact classes as the basis for its control and experimental groups, and students could self-select into these courses, we cannot say these courses were “randomly” assigned. According to Losh (2002), “suppose there was a systematic difference among groups before you applied any kind of intervention, such as Honors classes versus regular classes in school. In such a case, even random assignment of intact groups could not produce a true experimental design...So, study the situation carefully. ‘True experiments’ with intact groups are possible, but only under a very restricted set of conditions” (On Experimental Designs with Intact Groups section, para. 4 and 5).

While students self-select into classes, one could easily contend that the overall demographic makeup of these classes is as a whole equivalent. There are no special circumstances that would artificially place one student in a particular class versus any other. Arguably then, this study, although technically a quasi-experiment, approximates a true experiment. This is especially true in light of the fact that the non-equivalent control group design with pre- and post-test has been described as “one of the most commonly used quasi-experimental designs in educational research” (Cohen, Manion, & Morrison, 2007, p. 283). This is often the case since students are naturally organized in groups as classes within schools and are considered to share similar characteristics (Best & Kahn, 2006).

## **Definitions**

The following terms are defined for use in this study.

### ***Computer Literacy Terms***

In an attempt to set the context for the study, it is essential to define both computer literacy and computer competency/proficiency, as well as to highlight the major difference between the two concepts.

**Computer Literacy** – an understanding of the concepts, terminology and operations that relate to general computer use. It is the essential knowledge needed to function independently with a computer. This functionality includes being able to solve and avoid problems, adapt to new situations, keep information organized and communicate effectively with other computer literate people (Computer Literacy USA, 2012).

**Computer Competency / Proficiency** – a term related to one's ability to use a computer that is most often used when defining a requirement or proficiency standard. For example, Wayne State University has a basic computer competency requirement that indicates that all students must demonstrate:

1. Knowledge of basic computing concepts,
2. The ability to perform fundamental operating system functions,
3. The ability to use computers in a secure manner,
4. The ability to use common software applications, such as:
  - a) word processing
  - b) spreadsheet program
  - c) presentation software,
5. The ability to use the computer for Internet access and electronic communication

(Wayne State University, 2012)



**Computer Literacy vs. Computer Competency/Proficiency** – an important

distinction must be made between the two commonly used computer concepts of literacy and competency. Nearly all definitions of computer literacy involve the ability to use a computer to do specific things (computer proficiency). Less importance is placed on understanding the basic, underlying concepts (computer literacy). “It is important to realize that although what we do with computers changes over time, the basic concepts that govern how computers work, and how we manage the computer and information, do not” (Computer Literacy USA, 2012).

**Information Literacy** – a phrase most commonly associated with the American Library Association (ALA) and defined as the “set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information” (Information Literacy Competency Standards for Higher Education, 2012). The Information Literacy Competency Standards for Higher Education have stated that an information literate person:

- Determines the extent of information needed
- Accesses the needed information efficiently and effectively
- Evaluates information and its sources critically and competently
- Incorporates information effectively to accomplish a specific purpose
- Understands the economic, legal, and social issues surrounding the use of information

Information literacy, while showing significant overlap with information

technology skills, is a distinct and broader area of competence. A 1999 report from the National Research Council notes that “computer literacy” is concerned with rote learning of specific hardware and software applications, while “fluency with technology” focuses on understanding the underlying concepts of technology and applying problem-solving and critical thinking to using technology (National Research Council, 1999).

### ***Critical Thinking Terms***

The model chosen for use in this study was developed by the Foundation for Critical Thinking (FCT), an internationally recognized leader in critical thinking founded in 1981 by Richard Paul. Paul’s theoretical framework is highly regarded by others in the critical thinking field, both theoreticians as well as researchers. The following terms are for the most part taken from the FCT website and reflect the essential nature of Paul’s critical thinking model.

**Critical Thinking** – “That mode of thinking ... in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them” (Foundation for Critical Thinking, 2012).

**Elements of Thought** – According to Richard Paul, “All thought has a universal set of elements, each of which can be monitored for possible problems: Are we clear about our purpose or goal? About the problem or question at issue? About our point of view or frame of reference? About our assumptions? About the claims we are making? About the reasons or evidence upon which we are basing our claims? About our inferences and line of reasoning? About the implications and consequences that follow from our reasoning? Critical thinkers develop skills of

identifying and assessing these elements in their thinking and in the thinking of others” (Foundation for Critical Thinking, 2012).

**Higher Order Learning** – “Learning so as to deeply understand... Education for critical thought produces higher order learning .... Students should learn each subject by engaging in thought within that subject” (Foundation for Critical Thinking, 2012).

**Infer/Inference** – “A step of the mind, an intellectual act by which one concludes that something is so in light of something else's being so, or seeming to be so” (Foundation for Critical Thinking, 2012).

**Lower Order Learning** – “Learning by rote memorization, association, and drill.

There are a variety of forms of lower order learning in the schools which we can identify by understanding the relative lack of logic informing them.

Paradigmatically, lower order learning is learning by sheer association or rote.

Hence students come to think of history class, for example, as a place where you hear names, dates, places, events, and outcomes; where you try to remember them and state them on tests” (Foundation for Critical Thinking, 2012).

**Socratic Questioning** - “A mode of questioning that deeply probes the meaning, justification, or logical strength of a claim, position, or line of reasoning” (Foundation for Critical Thinking, 2012).

**Universal Intellectual Standards** - The intellectual standards are elements used to determine the quality of reasoning. Good critical thinking requires having a command of these standards. According to Paul and Elder (2010), the ultimate goal is for the standards of reasoning to become infused in all thinking so as to

become the guide to better and better reasoning. The intellectual standards include:

- Clarity
- Accuracy
- Precision
- Relevance
- Depth
- Breadth
- Logic
- Significance
- Fairness

### ***Experimental Term***

**Quasi Experiment** – a type of experiment that resemble quantitative and qualitative experiments, but lack random allocation of groups or proper controls, so firm statistical analysis can be very difficult. “For example, to perform an educational experiment, a class might be arbitrarily divided by alphabetical selection or by seating arrangement. The division is often convenient and, especially in an educational situation, causes as little disruption as possible. After this selection, the experiment proceeds in a very similar way to any other experiment, with a variable being compared between different groups, or over a period of time” (Experiment-Resources.com, 2012).

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **Introduction**

The disciplines of computer literacy and critical thinking have been developing in parallel over the last several years. This literature review will therefore begin by discussing computer literacy in general and by describing its historical trends, definitions, and significance. In addition, the current methods of teaching computer literacy will be examined.

A similar review will then take place into the field of critical thinking, again looking at the historical trends, definitions, significance, and educational approaches. The similarities and differences in the two areas of inquiry will be explored, leading to the argument that there is a need for the inclusion of critical thinking in computer literacy curriculum to enhance the learning of both disciplines and insights into the best approach to incorporating it into the curriculum.

## **Computer Literacy**

### ***History of Computer Literacy***

The teaching of Computer Literacy has roughly corresponded with four stages in the development of computer technology: the introduction of minicomputers in the 1970s, microcomputers or personal computers (PCs) in the 1980s, the Web as the defining Internet application in the 1990s, and portable and mobile (wireless) computing today (Hoffman & Blake, 2003).

As early as the 1970's the term *computer literacy* had officially emerged and “discussions about the computer literacy construct began to take a more philosophical base” (Perez & Coffin-Murray, 2010). Even still, the general public did not have widespread access to computers. Consequently, computer literacy at that time only included the need to know about computer technology necessary to “make informed decisions on public policy involving computers and their applications, and the need to tell the public about data processing and computing careers.” Hardware and software concepts and implications for society and individuals are the topics that were presented, but no actual hands-on participation was included (Hoffman & Blake, 2003).

A revolution took place in the 1980's with the arrival of the personal computer, making computing technology more widely available to the general public. With the introduction of the IBM and Macintosh Apple PCs, the general public was being introduced to the idea of owning their own computers. *Time Magazine* even named the computer its “Man of the Year” in 1982 (Carlson, Burgess, & Miller, 1996).

### ***Defining Computer Literacy***

Definitions of computer literacy from the 1980s included “the skills and knowledge needed by a citizen to survive and thrive in a society that is dependent on technology” (Hunter, 1984 as cited in Oliver & Towers, 2000), “appropriate familiarity with technology to enable a person to live and cope in the modern world” (Scher, 1984 as cited in Oliver & Towers, 2000), and “an understanding of computer characteristics, capabilities and applications, as well as an ability to implement this knowledge in the skillful and productive use of computer applications” (Simonson, et al., 1987 as cited in Oliver & Towers, 2000).

By 1985, computer literacy curriculums began to resemble today's definition. By 1987 computer applications had improved to the point where the ability to use them indicated computer literacy. Consequently, word processing, spreadsheets, business and presentation graphics, and file management became the core computer literacy topics. Furthermore, because PC applications had grown easier to use, companies began to view them as employment requirements (Hoffman & Blake, 2003).

The World Wide Web debuted in 1993, but it did not have an impact on computer literacy courses until later in the decade. Social and ethical aspects of computer use, however, became more prominent in courses, while application literacy addressed how to use applications to solve problems in specific knowledge areas (Hoffman & Blake, 2003).

Although the Web continued to grow rapidly, it had not fully caught on commercially and “home computer use had not yet reached critical mass, and online content providers had just begun to provide direct consistent connections to the

Internet and the Web.” The Internet did not emerge for the first time as a topic in computer literacy courses until 1997 (Hoffman & Blake, 2003).

A significant report by the National Research Council (1999) provided guidelines for the development of courses that provided “computer fluency” with information technology. The report identified three kinds of knowledge required for fluency with information technology: Contemporary skills (“the ability to use particular hardware or software resources to accomplish information processing tasks,”) fundamental concepts (the basic principles of information technology—“the book learning part of fluency,”) and intellectual capabilities (the ability to use information technology for organization, reasoning, and problem solving—“integrating knowledge specific to information technology with problem domains of personal interest to individuals.”)

As technology continued to advance, portable and mobile technologies became more commonplace, as did computer use in general. Computers with Internet connections could be found in most libraries, and many homes had multiple computers. Computers were becoming common in both workplace and academic settings. “Literacy topics included exploring how computers work; using applications such as word processing, spreadsheet, file management, database, and presentation graphics; finding useful information on the Web; examining the history and future of computers; and purchasing a computer” (Hoffman & Blake, 2003). Starting in 2000 we find definitions of computer literacy beginning to morph into the concept of information literacy or information fluency.

### ***Information Fluency***



Over the past fifteen years, computer and information literacy have started to merge. This process has been powered by an information explosion and the incredible advances in technology and their combined growing influence on society. (Ezziane, 2007, p.177). The National Research Council has identified several components as those necessary for “information fluency,” which can be grouped into the categories of intellectual capabilities, information technology concepts, and information technology skills.

**Table 1: The Components of Fluency with Information Technology**  
(Source: National Research Council, 1999)

<p><b>Intellectual Capabilities</b></p> <ol style="list-style-type: none"><li>1. Engage in sustained reasoning.</li><li>2. Manage complexity.</li><li>3. Test a solution.</li><li>4. Manage problems in faulty solutions.</li><li>5. Organize and navigate information structures and evaluate information.</li><li>6. Collaborate.</li><li>7. Communicate to other audiences.</li><li>8. Expect the unexpected.</li><li>9. Anticipate changing technologies.</li><li>10. Think about information technology abstractly.</li></ol> <p><b>Information Technology Concepts</b></p> <ol style="list-style-type: none"><li>11. Computers</li><li>12. Information systems</li><li>13. Networks</li><li>14. Digital representation of information</li><li>15. Information organization</li><li>16. Modeling and abstraction</li><li>17. Algorithmic thinking and programming</li><li>18. Universality</li><li>19. Limitations of information technology</li><li>20. Societal impact of information and information technology</li></ol>
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### **Information Technology Skills**

21. Setting up a personal computer
22. Using basic operating system features
23. Using a word processor to create a text document
24. Using a graphics and/or artwork package to create illustrations, slides, or other image-based expressions of ideas
25. Connecting a computer to a network
26. Using the Internet to find information and resources
27. Using a computer to communicate with others
28. Using a spreadsheet to model simple processes or financial tables
29. Using a database system to set up and access useful information
30. Using instructional materials to learn how to use new applications or features

These advances in technology and the “information explosion” have unquestionably changed the nature of education. As educators and institutions of higher education have struggled to find the correct approach to both teach within this new framework and also utilize it to its full potential, it is important to not focus exclusively on creating a new paradigm, but to also continue to incorporate those elements of higher education pedagogy that have consistently demonstrated success, such as cooperative and problem-based learning.

### ***Best Practices in Higher Education Pedagogy***

Each instructor uses his or her own approach to teaching and instructing, which he or she believes is the best for the students. Unfortunately, many educators seem unaware of the abundance of research in the teaching and learning sciences to support and question their teaching approaches. “Probably, the majority of instructors believe that they are following basic principles of effective instruction. However, many outside of faculties of education may not be aware that there is an extensive base of theory and research related to the science of teaching and learning in higher education and thus can benefit from becoming more aware of certain key principles” (Collis,

1998, p. 374).

For example, in *Pedagogies of Engagement: Classroom-Based Practices*, (2005), the researchers conclude, “Classroom-based pedagogies of engagement, such as cooperative learning and problem-based learning, can help break the traditional lecture-dominant pattern. To maximize students’ achievement, especially when they are studying conceptually complex and content-dense materials, instructors should not allow them to remain passive while they are learning” (p.11). By developing opportunities for cooperative and problem-based learning into classes and encouraging students to actively engage with the course material and teach it to one another, learning becomes less superficial and students are able to reach a greater depth of understanding and learning.

In their oft cited article, *Seven Principles for Good Practice in Undergraduate Education*, Chickering and Gamson (1987) also recommend active learning to educators as well as these other best practices:

**1. Encourage Contact Between Students and Faculty**

Student-faculty contact is the most important factor in student motivation and involvement.

**2. Develop Reciprocity and Cooperation Among Students**

“Good learning, like good work, is collaborative and social, not competitive and isolated... Sharing one's own ideas and responding to others' reactions sharpens thinking and deepens understanding.”

**3. Encourage Active Learning**

“Students do not learn much just by sitting in classes listening to teachers, memorizing pre-packaged assignments, and spitting out answers.” They must actively engage with the material, relating it to their experiences and daily lives.

“They must make what they learn part of themselves.”

#### **4. Give Prompt Feedback**

Students need appropriate feedback because it helps them to benefit from courses.

#### **5. Emphasize Time on Task**

Students need help in learning effective time management, so allocating realistic amounts of time for assignments means “effective learning for students and effective teaching for faculty.”

#### **6. Communicate High Expectations**

“High expectations are important for everyone – for the poorly prepared, for those unwilling to exert themselves, and for the bright and well-motivated.”

Consequently, high expectations encourage higher performance for everyone.

#### **7. Respect Diverse Talents and Ways of Learning**

“People bring different talents and styles of learning to college....Students need the opportunity to show their talents and learn in ways that work for them. Then they can be pushed to learn in new ways that do not come so easily.”

Best practices in undergraduate education are also finding their way into online courses, as is an increasing focus on teaching critical thinking skills. In a study by Osborne, Kriese, Tobey, and Johnson (2009), the researchers assembled various views

of critical thinking which they developed into a “scholarship of teaching and learning (SoTL) model” that was implemented into an Internet course.

The culmination of this research was the following recommendations that should be incorporated into course design so that critical thinking can be outlined, developed and demanded from students:

1. **Recitation** – state known facts or opinions and the ability to clearly be able to distinguish whether what is being stated is factual or based on opinion.
2. **Exploration** – analyze the roots of those opinions or facts. This step requires digging below the surface of what is believed or known, challenging assumptions, and working to discover the elements that have combined to result in that fact or that opinion.
3. **Understanding** – involves an awareness of other views and a comprehension of the difference(s) between one’s own opinion (and the facts or other opinions upon which that opinion is based) and the opinions of others.
4. **Appreciation** – a full awareness of the differences between our views and opinions and those of others. To truly appreciate differences, we must be aware of the nature of those differences.

As stated earlier, one of the tremendous strengths of the Paul-Elder model is its adaptability to a variety of disciplines and settings. For example, in the *Critical Thinking Handbook: High School* (Paul, Binker, Martin, & Adamson, 1989) it is easy to see how the following description of role of the teacher in the high school setting is equally relevant in a post-secondary setting as well (p. 25):

- Help break big questions or tasks into smaller, more meaningful parts
- Create meaningful contexts in which learning is valued by students
- Help students clarify their thoughts by rephrasing or asking questions
- Pose thought provoking questions
- Help keep the discussion focused
- Encourage students to explain things to each other
- Help students find what they need to know by suggesting and showing them how to use resources
- Ensure that students do justice to each view, that no views are cut off, ignored, or unfairly dismissed

Finally, in spite of the best intentions of instructors to create highly engaging and beneficial classes for students, according to Collis and Meeuwsen (1998), students want to move efficiently through their studies, in both time and energy; students do not automatically have good study skills, discipline, or motivation (as cited in Collis, 1998, 375). Of course the implications of this are that instructors must go beyond merely creating instructional content that is potentially beneficial but also help to equip students with the study skills, discipline, and motivation to effectively and efficiently learn this content.

Of course there are countless other theories and studies identifying best practices in higher education emerging every day, and it is the responsible educators' professional obligation to remain informed about these latest teaching developments.

## **Critical Thinking**

### ***History of Critical Thinking***

Although the discipline of critical thinking has been common in the educational literature for only the last several decades, the historical roots of critical thinking extend much further back.

The history of critical thinking dates back to the philosophers of Ancient Greece. While most historical accounts begin with a discussion of Socrates, what the pre-Socratic thinkers contributed was also significant – “they had given to nature a rational and non-mythical foundation. This new approach allowed a critical analysis of theories, whereas mythical explanations relied on blind faith alone” (Kreis, 2000).

### ***The Sophists***

The Sophists were nomadic professional educators and scholars who frequented Athens and other Greek cities in the second half of the fifth century. There were no formal schools as we know them today. Instead, these were “peripatetic schools” – the instructor would walk with students and talk with them – for a fee. In exchange for this fee, the Sophists offered young wealthy Greek men an education in *arête* (virtue or excellence) thereby attaining wealth and fame while also provoking significant hostility (Duke, 2012).

They taught the skills and ‘wisdom’ (*sophia*) of both rhetoric and oratory. Rhetoric can be described as the art of composition, while oratory was the art of public speaking (Kreis, 2000). Prior to the fifth century, *arête* was mostly associated with noble warrior qualities such as courage and physical strength. In democratic Athens of the latter fifth century, however, *arête* was increasingly thought of in terms of “the

ability to influence one's fellow citizens in political gatherings through rhetorical persuasion"; the sophistic education originated out of this shift. The most famous figures of the sophistic movement were Protagoras, Gorgias, Antiphon, Hippias, Prodicus and Thrasymachus (Duke, 2012).

The Sophists abandoned science, philosophy, mathematics and ethics, instead teaching the subtle art of persuasion. A Sophist was a person who could argue eloquently – and could prove a position whether that position was correct or incorrect. In other words, what mattered was persuasion and not truth. The Sophists were also relativists. They believed that there was no such thing as a universal or absolute truth that was valid at all times (Mastin, 2008).

### *Socrates*

From the ranks of the Sophists came Socrates (c.469-399 B.C.). Socrates came to the realization that when challenged, most people could not rationally justify their confident claims to knowledge. His most important contribution to Western thought was his Socratic Method – which solves a problem by breaking it down into a series of questions, the answers to which gradually lead to the problem solution. Socrates asked his pupils six categories of questions to strategically accomplish the following:

1. **Clarify concepts** – Getting them to think more about what exactly they were asking or thinking about using basic “tell me more” questions that got them to go deeper
2. **Probe assumptions** – Making them think about the presuppositions and unquestioned beliefs on which they were founding their argument
3. **Probe rationale, reasons and evidence** – Making them dig into their



reasoning rather than assuming it is a given

4. **Question viewpoints and perspectives** – Showing that there are other, equally valid, viewpoints
5. **Probe implications and consequences** – Making them question whether the argument that they give may have logical implications that can be forecast, do these make sense, or are they desirable
6. **Identify questions about the question** – Turning the question in on itself by using their attack against themselves (ChangingMinds.org, 2012)

Socrates used a method of probing questions to test the strength of claims made by those seen as the leading figures of his day. When challenging these so-called experts, Socrates found that information they presented as irrefutable knowledge could not withstand his questioning and measured scrutiny for supportable evidence, clarity, and logical consistency (Paul, Elder, & Bartell, 1997, para 1).

The Socratic Method asks thinkers to extend beyond everyday beliefs and explanations by provoking them to use logic and reason to substantiate their conclusions. The Socratic Method is one of the most well-known strategies to teach critical thinking (Paul, Elder, & Bartell, 1997, para 2).

Socrates' work was carried on by Plato, Aristotle, and the Greek skeptics, all of whom emphasized “that only the trained mind is prepared to see through the way things look to us on the surface ...to the way they really are beneath the surface” (Paul, Elder, & Bartell, 1997, para 4).

From this strong historical critical thinking foundation emerged a new realization – anyone who truly desired to embrace deeper realities must have the

ability to “think systematically, to trace implications broadly and deeply, for only thinking that is comprehensive, well-reasoned, and responsive to objections can take us beyond the surface” (Paul, Elder, & Bartell, 1997, para 4).

During the Middle Ages, the Catholic Church exerted tremendous control over political affairs as well as religion. This is evident in the following decree issued in 1075 by Pope Gregory VII:

(1) That the Roman [Catholic] Church was founded by God alone. (2) That the pope alone can with right be called universal. (3) That he can depose or restate bishops.... (10) That [the pope’s] name alone shall be spoken in churches. (11) That his name is the only name in the world. (12) That it may be permitted to him to depose emperors.... (19)

That he himself may be judged by no one.... (22) That the Roman Church has never erred; nor will it err to all eternity, the Scripture bearing witness. (Henderson, ed., 1892 as cited in Spielvogel, 2002)

It is clear by this decree that the Church of the Middle Ages intended to position itself as the ultimate authority in the matters of political affairs and societal matters in general.

In terms of control over religious matters, the Church utilized a variety of approaches. First and foremost, throughout most of the Middle Ages, Bible reading and interpretation were limited to religious leaders. Until the fifteenth century, the Bible was available only in Latin. Even when the Bible was translated into other languages, the scarceness and expense of Bibles kept them out of the hands of the average person. The availability of Bibles was therefore restricted by Church officials

During this era, the Bible was interpreted according to Church beliefs and traditions. There was little or no critical analysis or attempt made to determine the original meanings of the Scripture. Difficult passages “were interpreted as having a figurative meaning, so that they convey, through a kind of code, deeper truths about God, the spiritual life, or the church” (Christian Bible Reference site, n.d.).

In addition, the Church’s answer to discovering and dealing with heresy was the creation of a court known as the *Inquisition* or *Holy Office*. “The job of the court was to find and try heretics.” Those that confessed were publicly punished, and those that did not were tortured until they confessed. Those that did not confess were executed (Spielvogel, 2002, p. 327).

Beginning in about the eleventh century, *scholasticism* emerged—an attempt to “reconcile faith and reason—to show that what was accepted on faith was in harmony with what could be learned through reason” (Spielvogel, 2002, p. 330). In particular, the task of scholasticism was to harmonize Christian teachings with those of the Greek philosophers. Particularly troublesome to many Christian theologians in this effort were the works of Aristotle.

In his *Summa Theologica*, or *Summary of Theology*, Saint Thomas Aquinas made the most well-known attempt to reconcile Aristotle with Christian belief. Using a logical method of intellectual investigation, Aquinas first posed a question, he then cited sources that offered opposing opinions on the question, and then he reconciled them and offered his own conclusions (Spielvogel, 2002). Aquinas “took it for granted that there were truths arrived at by reason and truths arrived at by faith” (p.331).

By the Renaissance, scholars of critical thinking were numerous, particularly in

Europe. Prior to the Renaissance, there were significant restrictions to what a person could say that challenged the primary authorities of the time. Those authorities were the monarchy and the Catholics. The Renaissance was a determined (albeit at times covert) effort by scientists, artists, and philosophers to expose that official dogma is often wrong. It was the introduction of skepticism to a population of Europe that had been blindly following the instructions of the church under pain of death or excommunication (Beck, 2008).

In the late 16<sup>th</sup> century, Francis Bacon, in *The Advancement of Learning*, “laid the foundation for modern science with his emphasis on the information-gathering processes.” His writings affirmed that the nature and inclination of man was to come to conclusions that were not always based on fact. His book can be considered one of the earliest texts on critical thinking (Paul, Elder, & Bartell, 1997, para 7).

Fifty years later in France, Descartes wrote what can be called the second text in critical thinking, *Rules for the Direction of the Mind*. Descartes maintained the need for a special systematic disciplining of the mind to guide it in thinking, in which he stressed the significance of subjecting all beliefs to critical scrutiny (Paul, Elder, & Bartell, 1997, para 8).

In the 20<sup>th</sup> century, Dewey recognized the deep need for critical thinking in life and in education. In 1933 John Dewey wrote a pioneering book on reflective thinking entitled, *How We Think*. In the book Dewey began “to shape and define critical thinking. Some view this book as the early stirring of the paradigm shift in education” (Yildirim & Özkahraman, 2011, pp. 127-128).

## *Definitions of Critical Thinking*

Critical thinking is an abstract, complex concept that is difficult to define. There are multiple definitions of critical thinking in the literature, but there are common threads in many of these definitions. For example, focus on metacognition and self-regulation is found in many of these definitions. John Dewey's (1933) ideas about reflective thinking are expressed in the following statements:

### Reflective thinking

- makes possible action with a conscious aim—it allows us to “act in deliberate and intentional fashion” (p. 212)
- makes possible systematic preparations and inventions—“by thought man also develops and arranges artificial signs to remind him in advance of consequences and of ways of securing and avoiding them” (p.213)
- enriches things with meanings—“thought confers upon physical events a very different status and value from those which they possess to a being that does not reflect” (p. 214)

Richard Paul provides us with a comprehensive critical thinking definition:

According to Paul (1993), critical thinking is:

A unique kind of purposeful thinking in which the thinker systematically and habitually imposes criteria and intellectual standards upon the thinking, guiding the construction of the thinking according to the standards, and assessing the effectiveness of the thinking according to the purpose, the criteria, and the standards (p. 21).

Robert Ennis defines critical thinking as “reasonably reflective thinking focused on deciding what to believe or do” (Ennis, 2011), and (Facione and Facione, 1996) classify critical thinking as “a nonlinear, recursive process in which a person forms a judgment about what to believe or what to do in a given context. In so doing, a person engaged in CT uses a core set of cognitive skills—analysis, interpretation, inference, explanation, evaluation, and self-regulation—to form that judgment and to monitor and improve the quality of that judgment” (p.131).

In 1990, the American Philosophy Association, in an attempt to bring some consensus to the definition, created a multidisciplinary committee of forty-six published critical thinking experts from philosophy, education, and psychology, including Robert Ennis, Stephen Norris, and Richard Paul (Facione, 2011). This committee conducted a Delphi research project leading to the development of a consensus definition and conceptualization of critical thinking and its core cognitive skills and affective dispositions. The cognitive skills that the experts agreed to as being at the very core of critical thinking were interpretation, analysis, evaluation, inference, explanation, and self-regulation.

The panel defined *inference* as comprehending and expressing meaning about a wide variety of experiences, beliefs, procedures, rules, etc. *Analysis* was found to be about identifying the relationship between statements, questions, concepts or descriptions to express beliefs, judgments or reasons. The experts felt that *evaluation* was about assessing credibility of statements and representations of others as well as assessing the logical strength of statements, descriptions or questions. *Inference* was

found to be the ability to draw reasonable conclusions and/or hypotheses based on facts, judgments, beliefs, principles, concepts or other forms of representation.

The experts believed *explanation* to be about stating and justifying the results of one's reasoning using each of the aforementioned abilities. *Self-regulation*, the last skill, was found to be the ability of individuals to monitor their own personal cognitive activities to make sure that they are engaged in critical thinking. The experts went on to conclude that “the ideal critical thinker can be characterized not merely by her or his cognitive skills but also by how she or he approaches life and living in general” (Facione, 2011, p. 10).

The consensus of the panel was that:

...the ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. (Facione, 2011, p. 26)

The final definition of the project was that critical thinking is:

...purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference, as well as explanation of the evidential, conceptual, methodological, criteriological or contextual considerations upon which that judgment is based. (Facione, 2011, p. 22)

## ***Teaching Critical Thinking***

Many critical thinking researchers maintain that critical thinking skills and abilities can be taught, and many institutions of higher learning are recognizing its importance by including critical thinking in goals for learning outcomes or in core requirements. However, there is still much disagreement regarding how to best approach including critical thinking within the curriculum.

### ***Stand-Alone vs. an Integrated Approach***

One major point of disagreement is whether critical thinking is best learned as a stand-alone course or integrated throughout the curriculum. The debate about domain specificity has implications for critical thinking instruction. Ennis (1989) identifies four instructional approaches that vary in terms of the degree to which critical thinking skills are taught as a stand-alone course versus integrated into regular instruction.

- **The general approach** – General critical thinking instruction “attempts to teach critical thinking abilities and dispositions separately from the presentation of the content of existing subject-matter offerings, with the purpose of teaching critical thinking” (p.4).
- **The infusion approach** – “Infusion of critical thinking instruction in subject-matter instruction is deep, thoughtful, well understood subject-matter instruction in which students are encouraged to think critically in the subject, and in which general principles of critical thinking dispositions and abilities are made explicit.” Proponents of the infusion approach include Glaser, Resnick, and Swartz (p. 5).
- **The immersion approach** – “Immersion is ... subject-matter instruction in which students do get deeply immersed in the subject, but in which general critical



thinking principles are not made explicit.” McPeck is the major proponent of the immersion approach (p. 5).

- **The mixed approach** – “The mixed approach consists of a combination of the general approach with either the infusion or immersion approaches. Under it there is a separate thread or course aimed at teaching general principles of critical thinking, but students are also involved in subject-specific critical thinking instruction.” Proponents of the mixed approach include Ennis, Sternberg, Nickerson, and Perkins and Salomon. (p. 5).

In his research, Nosich (2005) discusses two common models for teaching critical thinking, and the inherent weakness in both approaches. In what he calls the “one-of-many” model, “an instructor teaches by making critical thinking a part of the class but also uses a number of other ways to help students learn material. In this model, critical thinking is only one method among many for helping students learn the subject matter” (p. 60). One of the weaknesses of the “one-of-many” model is that it assumes that there are other practical ways for students to learn the material besides “learning to think their way through it” (p. 62). Nosich makes the case that critical thinking is central to all genuine learning.

In the second model, what Nosich refers to as the “cover as much content as possible” model, content is addressed as a long list of concepts and ideas, ranging from the most general to more specific. From this list of concepts, teachers select questions and problems for students to work on, often as presented in the textbook. Teachers may or may not use individual critical thinking activities to promote understanding of selected

topics as they are addressed. The “cover as much content as possible” model makes the assumption that students naturally learn to think critically within the discipline and discover how its parts relate to one another by having to work through multiple disconnected and randomly chosen topics. This assumption fails to consider the central role of fundamental concepts and ideas in learning to think within and through a discipline (Nosich, 2005).

Therefore, according to Nosich (2005):

A teaching model that focuses on topics that, in the student’s mind, are disconnected from one another misses the crucial insight that a field is itself a system of thinking. A discipline has logic to it. It is not a set of discrete concepts, ideas, and procedures that can be fruitfully thought about in isolation from one another. To teach a discipline is to teach students how to reason through the logic of the discipline, how to use that system of thinking to analyze problems and situations (p. 65).

### ***Assessing Critical Thinking***

There are many critical thinking assessment tests available that will effectively measure critical thinking skills. Examples of these critical thinking assessment tests include the *Watson-Glaser Critical Thinking Appraisal (WGCTA)* test, the *Thurstone Test of Mental Alertness*, the *Cornell Critical Thinking Test*, the *California Critical Thinking Skills Test (CCTST)* and the *International Critical Thinking Basic Concepts and Understandings Test*.

The *International Critical Thinking Basic Concepts and Understanding Test* is based on the model of critical thinking developed by Richard Paul and his colleagues at the Foundation for Critical Thinking. In addition, it is the only critical thinking test that approaches critical thinking as a multidisciplinary system of interconnected concepts, principles, and understandings, focusing on the five essential dimensions of critical thinking:

1. The analysis of thought
2. The assessment of thought
3. The dispositions of thought
4. The skills and abilities of thought
5. The obstacles or barriers to critical thought

In addition, the test is designed for use at the high school level (grade 10) and above (college, university, graduate level), can be easily administered online, and takes approximately 30-45 minutes to complete. Furthermore, the test is packaged on a per student basis, rather than per test. Each student may take the test up to eight times over four years, making its use conducive to a longitudinal study should further research warrant such an examination.

Because of the test's strong alignment with Richard Paul's model of critical thinking as well as its ease of use, it was selected for use in this study as a pre- and post-test assessment of critical thinking skills for the experimental and control groups.

## **Summary of Literature**

The disciplines of computer literacy and critical thinking have been developing in parallel over the last several years and both have been identified as vital skills for the 21<sup>st</sup> century. Definitions of computer literacy have changed repeatedly over the last 40 years in an attempt to keep up with the rapidly changing field of computer technology. Over the past fifteen years in particular, computer and information literacy have started to merge.

This process has been powered by an information explosion as well as the advances in technology and their combined growing influence on society. Current guidelines for the development of courses that lead to “computer fluency” with information technology identify three kinds of required knowledge: contemporary skills (the ability to use particular hardware or software resources to accomplish tasks), fundamental concepts (the basic principles of information technology), and intellectual capabilities (the ability to use information technology for organization, reasoning, and problem solving).

There have also been several advances in the discovery of best practices in higher education pedagogy. In particular, researchers have discovered the importance of such factors as active engagement, instructor-student interaction, and student-student interaction including cooperative and problem-based learning in successful student educational outcomes.

In spite of efforts to reach consensus, experts have not uniformly agreed on a definition of critical thinking. However a focus on metacognition and self-regulation is found in many of these definitions. The degree to which teaching for critical thinking

within specific domains transfers to other fields and to everyday reasoning has remained a source of debate as well, but being explicit and providing application seems to make the likelihood of transfer more likely.

The research literature examining teaching for critical thinking in certain disciplines is beginning to emerge, because computer literacy as a discipline is still in its relative infancy, research regarding critical thinking in computer literacy courses is nonexistent. Studies are therefore needed to determine which strategies aid in developing students' abilities to think critically in computer literacy coursework.

Based on the literature review, Richard Paul's model appeared to be the best choice for incorporating a solid and useful concept of critical thinking into computer literacy courses. Paul's model was selected from among several general critical thinking models for investigation in this study because of its rich theoretical foundation, its flexibility and applicability to a wide range of circumstances requiring good reasoning, its limited use of specialized jargon, and its inclusion of standards and dispositions.

Research also revealed many critical thinking assessment tests available that effectively measure critical thinking skills. The *International Critical Thinking Basic Concepts and Understanding Test* is based on the model of critical thinking developed by Richard Paul and his colleagues at the Foundation for Critical Thinking. Because of the test's strong alignment with Paul's model of critical thinking as well as its ease of use, it was selected for use in this study as a pre- and post-test assessment of critical thinking skills for the experimental and control groups.

This researcher expected to see the following results: Explicitly teaching Paul's model for critical thinking and providing practice in using it to evaluate and solve

computer literacy questions and simulated problems would produce higher scores among research participants on tests of computer literacy and critical thinking dispositions than the traditional method of instruction used as a control.

## **CHAPTER 3**

### **METHODOLOGY**

#### **Introduction**

Computer literacy and critical thinking have been identified as two vital skills necessary for success in the 21<sup>st</sup> century. The purpose of this study is to determine if teaching a computer literacy class utilizing a critical thinking approach based upon Richard Paul's model of critical thinking can make a significant improvement in student learning. The expectation was that this quasi-experiment would indicate a positive direct relationship between instruction in critical thinking skills when infused into the teaching of course content and the improvement in both critical thinking skills and academic achievement in subject matter, as measured by pre- and post-test scores on the *International Critical Thinking Basic Concepts and Understandings Test*, and pre- and post-test scores on the Certiport IC<sup>3</sup> Certification Exams.

#### **Research Design**

This study was an attempt to determine how the infusion of a critical thinking skills component into a computer literacy course could improve both the critical thinking and computer literacy competency of students during a semester-length computer literacy

course at a small rural community college. Due to the nature of the research, an experimental design was warranted in that this researcher was looking to identify a cause-effect relationship and the condition was not pre-existing, so it would need to be manipulated for the purposes of the study. In particular, because assignment was non-random, a quasi-experimental, non-equivalent control group design was used to measure the effects of a critical thinking/computer literacy curriculum relationship.

Although quasi-experimental designs do not allow the same degree of certainty about cause-and-effect relationships as an experiment does, a well-designed quasi-experiment can provide convincing circumstantial evidence regarding the effects of one variable on another. It is therefore hoped that this study will provide valuable insight for future studies into similar curriculum integration with regards to critical thinking (National Center for Technology Innovation, n.d.).

### **Sampling**

According to Vogt (2007), “among equally representative samples, bigger is always better. The bigger the sample is, the smaller the sampling error and the greater the statistical power” (p. 84). Put another way, larger samples tend to be more representative of the populations from which they are drawn and therefore able to more successfully reveal true relationships among variables.

However Vogt (2007) goes on to say that, especially in educational research “in experiments, there is rarely any known population from which a sample is drawn. Or if such a population is known, no one is very interested in it; it is not what is being studied....the general idea is to *find* an effect, a causal relationship. For the purposes of *discovery*, representative samples are less crucial.” If such relationships are identified,



subsequent studies can estimate generality by examining samples that are more representative. (pp. 104-105).

For this study the sample was drawn from a population of 286 students enrolled in eleven sections of the *Introduction to Computers* course taught during the fall 2012 semester with an enrollment of 26 students in each. These classes had a standardized curriculum with identical assignments, grading structures, and expectations. Six of the eleven classes were randomly selected for the study, with three randomly assigned to the experimental group (78 students) and three randomly assigned to the control group (78 students).

The sample was essentially a convenience sample in which students were clustered by class. Random selection was therefore not the case, as students self-select into classes. Nevertheless, because the classes are standard in nature and the classes were randomly assigned by the researcher into either the experimental or control groups, the experiment as closely as possible approximated a true experiment. In truth, however, it was a quasi-experiment, one that is similar to true experimental design but lacks random assignment.

Because of the lack of random assignment (self-selection of students into classes), in order to keep internal validity high it was important, as much as possible, to establish uniformity between the experimental and control groups for purposes of the study in order to control for confounding variables. In particular, a *nonrandomized control group pre-test – post-test design* was used.

N1: O → X → O  
N2: O → O

By giving both the experimental and control groups a pre-test and a post-test, it was possible to statistically determine if any significant differences existed between the two groups that may act as confounding variables in isolating the effects of introducing the treatment (critical thinking instruction) in the experimental group.

Appropriate training (see Instructor Training, page 65) was given to instructors that participated in the experiment to ensure consistency between the experimental group and control group on all aspects other than the treatment. Further training was given to all instructors who introduced the treatment to ensure consistency in the delivery of this instruction.

### **Instrumentation**

In the case of this quasi-experiment, both the control and experimental groups as selected above were given the *International Critical Thinking Basic Concepts and Understandings Test* as both a pre- and post-test measure of critical thinking, and the Certiport IC<sup>3</sup> Certification exams as a pre- and post-test measure of computer proficiency during the fall 2012 semester.

#### ***International Critical Thinking Basic Concepts and Understandings Test***

The *International Critical Thinking Basic Concepts and Understandings Test*, “developed by leading international authorities on critical thinking, Dr. Linda Elder and Dr. Richard Paul, along with Foundation for Critical Thinking Research Fellow Rush Cosgrove, is the first comprehensive and foundational critical thinking concepts and principles test to be developed and offered for online use” (Foundation for Critical Thinking, 2011).

It is based on the model of critical thinking developed by Paul and his colleagues at the Foundation for Critical Thinking. It is the only critical thinking test that approaches critical thinking as a transdisciplinary system of interconnected concepts, principles, and understandings, focusing on the five essential dimensions of critical thinking:

1. The analysis of thought.
2. The assessment of thought
3. The dispositions of thought
4. The skills and abilities of thought
5. The obstacles or barriers to critical thought.

The test is a three-part, 100-item test designed for use at the high school level (grade 10) and above (college, university, graduate level). The test takes approximately 30-45 minutes to complete.

### ***Certiport IC<sup>3</sup> Examinations***

Certiport's IC<sup>3</sup> certificate is awarded to those individuals that take and are able to pass three separate exams, titled Computing Fundamentals, Key Applications, and Living Online. Each exam of the IC<sup>3</sup> consists of 45 multiple choice, matching, and simulated, problem-based questions. Each exam also has a 45-minute time limit. The maximum score is 1000, and the minimum passing requirement is 710 for Computing Fundamentals, 680 for Key Applications and 660 for Living Online.

### **Instructional Method and Materials**

Student participants used one textbook: Computer and Internet Essentials, Preparing for IC<sup>3</sup> by Nita Rutkosky, Audrey Roggenkamp, Ian Rutkosky, and Faithe

Wempen (2012). This textbook was adopted for use in all sections of *Introduction to Computers* at the institution in both the control group and experimental group participating in the study. Furthermore, participants in both groups were given the same reading assignments, end-of-chapter quizzes, skill-builder exercises, and practice test requirements. Therefore, the only instructional difference between the groups was the infusion of critical thinking into the experimental group through a different method of instruction, the explicit teaching of critical thinking concepts, and the introduction of additional exercises that encouraged critical thinking.

### ***Control Group***

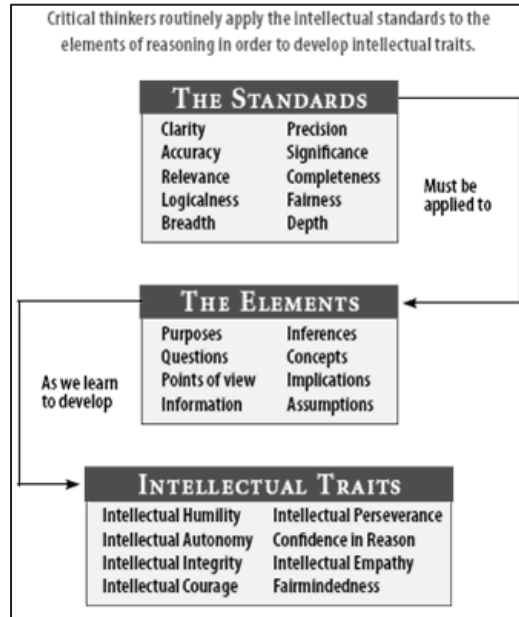
The primary format for the control group was weekly reading assignments from the course textbook followed by related in-class lectures. Furthermore, as stated above, students were assigned accompanying chapter quizzes, skill-builder exercises, and practice tests to assess and enhance their comprehension of the content and prepare them for taking the Certiport IC<sup>3</sup> Certification exams.

### ***Experimental Group***

Richard Paul's model for critical thinking (Foundation for Critical Thinking, 2011) was used as the basis for the experimental treatment in this study.

Paul's model includes elements of reasoning, universal intellectual standards used to assess student reasoning, and traits or virtues of the reasoning mind. It is a general model of reasoning that can be applied to any problem or issue requiring reasoning, and was therefore chosen because it incorporates critical thinking standards and because its flexibility allows it to be integrated into any academic content and has the additional

benefit of being valuable for thinking about both academic subjects as well as everyday issues. A graphic summary of the basic model is presented in Figure 1.



**Figure 1: Richard Paul’s Model for Critical Thinking**

### **Instructor Training**

Prior to the present study, the researcher participated in training in general features of Paul’s model by attending a three-day conference presented by the *Foundation for Critical Thinking*. This training included an overview of the model and practice in using the model in classroom discussions and development of course materials.

Additionally, the researcher created and delivered two critical thinking workshops teaching faculty at a community college how to implement Richard Paul’s model into

their approach to teaching, and subsequently presented the same workshop at a state-wide conference.

Participants in the experimental group participated in all of the same activities as those listed for the control group as explained in the prior section. In addition, the instructors infused Paul's model into the experimental sections by (a) providing a lesson plan for instructors (Appendix B) stressing making students explicitly aware of what was expected of them in the course, and focusing on activities that encourage active learning, (b) having students sign a Student Understanding Form (Appendix C), again making them explicitly aware of the nature of the course and the expectations for their involvement, (c) giving students a Critical Thinking Packet (Appendix D) to explain the definition and nature of critical thinking as well as to explicitly teach elements of Paul's model, (d) giving students a special course syllabus emphasizing the unique nature of the course (Appendix E), and (e) giving assignments that required students to use the model to think critically within the discipline of computer literacy.

In their book, *A Miniature Guide for Those Who Teach on How to Improve Student Learning: 30 Practical Ideas*, Paul & Elder (2007) offer several useful strategies for infusing critical thinking into instruction, the following of which were implemented for this study:

- Design instruction so that students engage in routine practice in internalizing and applying the concepts they are learning (p. 4)
- Use engaged lecture (p. 13) – Call on students to state, elaborate, exemplify, and illustrate (in their own words) the most important points in a lecture or chapter in the textbook.

- Give students a thorough orientation to the course (p. 15)
- Develop a syllabus which highlights your expectations for the students (p. 16)
- Use a “student understanding” form (p. 24) See Appendix C.
- Explain to the students, when orienting them to the class, what will happen on a typical class day (and why) (p. 25)
- Explain the key concepts of the course explicitly during the first couple of class meetings (p. 26)
- Discuss class time as a time in which the students will PRACTICE thinking (within the content) using the fundamental concepts and principles of the field (p. 27)
- Think of yourself as a coach (p. 29)
- Encourage students to think – quite explicitly – about their thinking (p. 31)
- Relate content whenever possible to issues, problems, and practical situations in the lives of your students (p. 33)
- Use tactics that encourage active learning (p. 35)
- Routinely ask questions that probe student understanding of the content (p. 36)  
See Appendix F: Student Critical Thinking Assignments
- Model skilled thinking for your students (p. 37)
- Bring intellectual standards into daily use (p. 40)
- Systematically question students using a Socratic approach (p. 42)

For a more detailed description of how these strategies were incorporated into the instruction of the experimental group, see the Appendix B: Lesson Plan for Instructors.

### **Threats to Internal Validity**

- Maturation / history – was not a factor given the short duration of the study
- Testing – this threat to validity occurs because taking a test generally affects subsequent testing; thus, participants’ performance on a measure at the end of the study may differ from an initial testing, not because of treatment but because they are familiar with the measure. This was not considered to be a threat because testing instruments used in the study pull a random set of questions from a larger test bank for each attempt.
- Instrumentation — occurs when instruments used to measure participants’ performance may change over time; thus, changes in participants’ performance may not be due to treatment but to changes in the instruments used to measure performance. This was not a factor in this study because the instruments used for pre- and post-testing remained consistent for the duration of the study.
- Mortality—some students dropped out during the experiment. The researcher observed for mortality by monitoring attendance data. Students who left during the course of the semester were removed from the semester analysis. Pre-test results were examined for those dropping out of the study to determine if they represented a special segment of the sample, and a comparison was made between those dropping out from the experimental group and the control group.

### **Threat to External Validity**

The biggest threat to external validity was the narrow focus of the study. This experiment took place at one small rural community college with a relatively small sample during one semester. In order to increase external validity the study should be



replicated over another semester using a different sample group and, if possible, attempts should be made to replicate the study in a different institution with similar goals regarding computer literacy and critical thinking.

### **Data Analysis**

As stated earlier, a quasi-experimental control group pre-test – post-test design was used. By giving both the experimental and control groups a pre-test and a post-test, it was possible to determine if any significant differences existed between the two groups that may act as confounding variables in isolating the effects of introducing the treatment (critical thinking instruction) in the experimental group. Performances on the International Critical Thinking Basic Concepts and Understandings Test pre-test and the Certiport IC<sup>3</sup> Certification pre-tests were therefore compared between the control group and experimental group by running an independent t-test to look for statistically significant uniformity between the two groups.

Statistics were also used to compare performance on the computer literacy and critical thinking pre- and post-tests for both the control group and the experimental group to evaluate changes during the course of the study in order to evaluate the impact of introducing the treatment to the experimental group.

#### *Descriptive Statistics*

Even though the data analysis for this study drew its main conclusions using inferential statistics, descriptive statistics were also presented.

For example, the three major types of estimates of central tendency were presented, the mean, the median, and the mode. In addition, measures of dispersion, the spread of values around the central tendency, were also presented, namely the range and

the standard deviation. By calculating and examining these descriptive statistics in both the control and experimental groups, a picture started to emerge regarding the proposed hypotheses.

### *Inferential Statistics*

An independent t-test was used to compare the means of the control group to the experimental group on both of the pre-tests. In this case, the preferred finding was that the groups would show no statistical difference. If this is the case, an independent t-test will then subsequently be used to also compare the means of the differences of pre-tests to post-test scores of the control group to test for statistically significant difference between the groups. Eta squared will also be calculated to measure the effect size, if any.

The chosen statistics were appropriate because they provide evidence to either support or reject the proposed hypothesis. Beginning with the descriptive statistics, a picture will begin to emerge regarding the degree of similarity between the control and experimental groups, as well as to what degree the introduction of the treatment for the experimental group impacted post-test scores. The use of the independent t-test is appropriate in that it measures how different (or similar) two samples are (the t-value) as well as how likely it is that such a difference would appear in two samples from the same population (the p-value). It can thus be used to confirm, or reject, the similarity between the experimental and control group, and look for any significant differences between the experimental and control groups following the introduction of the treatment to the experimental group.

The independent t-test compares the means between two unrelated groups on the same continuous, dependent variable. For example, in this study the researcher will use

an independent t-test to understand whether students in a computer literacy course perform differently (based on the mean of the differences of pre- to post-test scores between the two groups) depending on the introduction of an experimental treatment of a critical thinking approach. (i.e., the dependent variable would be “pre- to post-test differences between the two groups” and the independent variable would be “treatment (experimental) vs. non-treatment (control) groups” (Laerd Statistics, 2013).

According to Laerd Statistics, 2013), when choosing to analyze data using an independent t-test, part of the process involves checking to make sure that the data can actually be analyzed using an independent t-test. It is only appropriate to use an independent t-test if the data “passes” six assumptions that are required to give a valid result.

The six assumptions are as follows:

- Assumption #1: The dependent variable should be measured at the interval or ratio level (i.e., they are continuous). The data for the dependent variable for this study meets this criterion because it is a numeric difference between test scores.
- Assumption #2: The independent variable should consist of two categorical, independent groups. Because this study is an experiment with a control group, it meets this criterion because the independent variable is the treatment (experimental) vs. non-treatment (control) groups.
- Assumption #3: There should be no relationship between the observations in each group or between the groups themselves. For example, there must be different participants in each group with no participant being in more than one group. The

design of this study meets this criterion. No student was assigned to both the control and the experimental groups.

- Assumption #4: There should be no significant outliers. Outliers are single data points within the data that do not follow the usual pattern. The problem with outliers is that they can have a negative effect on the independent t-test, reducing the accuracy of the results. This study meets this criterion. SPSS was used to test for outliers in the data and the 5% trimmed mean was acceptable.
- Assumption #5: The dependent variable should be approximately normally distributed for each category of the independent variable. This study meets this criterion. The Kolmogorov-Smirnov test was used to check for normal distribution among each category of the independent variable.
- Assumption #6: There needs to be homogeneity of variances. This study met this criterion. SPSS was used to run Levene's test for homogeneity of variances.

### *Qualitative Analysis*

In addition to the quantitative analysis, a short qualitative analysis was performed in the form of a focus group with instructors from the experimental group regarding their perceptions of the nature of the course and its impact on students.

## **Discussion and Conclusions**

### *Possible Findings*

The hypothesis for this study was that there would be a positive direct relationship between the infusion of instruction in critical thinking skills in a computer literacy course and the improvement in both critical thinking scores and computer literacy scores on assessment tests in a statistically significant way, meaning both post-test scores from the

experimental group would be higher than the post-test scores from the control group in a statistically significant way.

Alternately, it was possible that the data may indicate that the null hypothesis was true – that there was not a relationship between critical thinking instruction and improved critical thinking and computer literacy scores, meaning the difference in the post-test scores between the control and experimental groups was not statistically significant.

Yet another possibility was that the introduction of the computer literacy module would improve either the critical thinking score or the computer literacy in a statistically significant way, but not both.

Finally, there was always the possibility that there may be an inverse relationship between critical thinking instruction and the direction of scores on the post-test critical thinking assessment, the post-test computer literacy assessment, or both.

#### *Implications for Further Research*

Should the hypothesis that introducing critical thinking skills into the computer literacy curriculum has a positive impact on the learning of both skill sets be supported, this result opens the door for further research. First and foremost, it would be important to replicate the study both at the same institution using different students during a different semester, as well as at different institutions, both community colleges and 4-year universities. These new studies may also want to consider utilizing other instruments to measure critical thinking and computer literacy so as to confirm the validity of the instruments used in this study.

Should such studies show similar promising results, this could in turn open the door to even further studies measuring the effect of introducing critical thinking into

other disciplines beyond computer literacy. As indicated in the literature review, critical thinking is and will continue to be a fundamental ingredient in student success, and finding ways to successfully teach it across the curriculum seems to be a worthwhile pursuit.

## **CHAPTER 4**

### **FINDINGS**

#### **Introduction**

The purpose of this experimental study was to identify any relationship between teaching computer literacy utilizing Richard Paul's model for critical thinking and improved student performance in an introductory computer literacy course. The independent variable in this study was the method of instruction (instruction that included Paul's model and instruction that did not). Outcome variables were scores obtained on four instruments:

- The International Critical Thinking Basic Concepts and Understandings Test
- Certiport's three IC<sup>3</sup> Computer Literacy exams
  - Computing Fundamentals
  - Key Applications
  - Living Online

This chapter reports results of the experimental study as they relate to the research questions. A description of the sample is provided, followed by an overview of the data analysis procedures used in the study. Then results from each of the four instruments are

presented in turn. Statistical analyses were run with IBM SPSS Statistics software, version 19 (Statistical Product and Service Solutions, 2012).

This chapter concludes with a summary of results of interviews with instructors of the experimental groups to gain insights into what seemed to work well and what areas could be improved in future studies

## **Quantitative Analysis**

### *Description of Sample*

Total student enrollment in the six sections at the beginning of the semester (following the end of the drop-add period) was 110. All students consented to participate in the study. Based on prior statistics in the computer literacy course, it was anticipated that approximately 19% of the students would either withdraw from the course or stop attending before the completion of the semester. During the semester of the research study, 18 of the original 110 students (16%) who had been enrolled at the beginning of the semester in the six sections included in the research study failed to complete the course, leaving a total of  $N=92$ .

In the three experimental sections, 13.2% (7 of 53 students) failed to complete the course, and in the three control sections, 19.3% (11 of 57 students) failed to complete the course.

Descriptive statistics for the sample on each of the four pretest/posttest instruments are presented in Table 2 (CT=Critical Thinking, CF = Computing Fundamentals, KA=Key Applications, LO=Living Online). They are presented for the total number of students that completed all aspects of the course and the study ( $N = 92$ ), thus excluding those students that dropped out before the completion of the study.



**Table 2: Descriptive Statistics**

Descriptive Statistics							
	N	Min	Max	Mode	Median	Mean	Std. Deviation
CT Pre	92	21	73	46	44.5	44.21	9.351
CT Post	92	21	67	48	44.0	43.21	9.815
CF-Pre	92	360	890	580	600	609.90	120.552
CF-Post	92	467	978	822	789	770.98	114.114
KA-Pre	92	220	889	580	580	588.29	127.325
KA-Post	92	400	978	956	844	822.61	106.762
LO-Pre	92	490	930	620	700	698.84	99.376
LO-Post	92	467	933	756	756	762.30	96.732

Table 3 further breaks down the data by summarizing the means, standard deviations, and standard error means for both the control group and the experimental group for each of the pre- and post-test instruments.

**Table 3: Group Statistics**

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
CT Pre	Control	46	42.91	8.763	1.292
	Experimental	46	45.50	9.829	1.449
CT Post	Control	46	41.39	9.047	1.334
	Experimental	46	45.02	10.307	1.520
CF-Pre	Control	46	601.54	114.173	16.834
	Experimental	46	618.26	127.319	18.772
CF-Post	Control	46	755.54	116.373	17.158
	Experimental	46	786.41	110.923	16.355
KA-Pre	Control	46	609.41	147.399	21.733
	Experimental	46	567.17	100.723	14.851
KA-Post	Control	46	820.74	122.723	18.095
	Experimental	46	824.48	89.338	13.172
LO-Pre	Control	46	716.07	93.440	13.777
	Experimental	46	681.61	103.116	15.204
LO-Post	Control	46	750.28	97.844	14.426
	Experimental	46	774.33	95.148	14.029

### *Pre-Test Analysis*

An independent t-test was conducted to compare the experimental and control groups (see Table 4). The results indicate no statistically significant difference between the groups in computer literacy and critical thinking before the start of the study (critical thinking,  $t = -1.332$ ,  $p > 0.05$ , computing fundamentals,  $t = -0.663$ ,  $p > 0.05$ , key applications,  $t = 1.605$ ,  $p > 0.05$ , and living online,  $t = 1.679$ ,  $p > 0.05$ ). Accordingly, equality of groups at baseline suggests that it is appropriate to conduct the experiment and subsequently compare the critical thinking and computer literacy knowledge of the groups.

**Table 4: Independent Samples Test on Pre-Test to Determine Equivalency in Groups**

Independent Samples Test				
	F	t	df	Sig (2-tailed)
CT Pre	0.555	-1.332	90	.186
CF-Pre	0.802	-0.663	90	.509
KA-Pre	4.507	1.605	90	.112
LO-Pre	0.263	1.679	90	.097

### *Post-Test Analysis*

When performing independent t-test analysis on the combined differences between the pre- and post-test scores for the three computer literacy instruments, the results showed significant differences between the experimental and control groups in computer literacy,  $t = -2.983$ ,  $p < 0.05$ , (see Table 6). This indicates that students' in the

treatment group had a higher overall knowledge of computer literacy compared to the control group, thus rejecting the null hypothesis. Furthermore, an estimate for the effect size for the independent-samples t-test can be calculated by using the following formula for Eta squared (Pallant, 2007, p. 236):

$$\text{Eta squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)}$$

$$\text{Eta squared} = \frac{-(2.983)^2}{-(2.983)^2 + (46 + 46 - 2)}$$

$$\text{Eta squared} = .09$$

This indicates a moderate to large effect of the treatment on the improved outcomes in computer literacy in the experimental group, with approximately 9% of the variance in computer literacy scores being explained by the treatment.

**Table 5: Group Statistics Combined Difference in Mean of Pre- to Post-Test for All Computer Literacy Test Instruments**

<b>Group Statistics (Combined Difference in Mean of Pre- to Post-Test for All Computer Literacy Test Instruments)</b>			
<b>Group</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Std. Error Mean</b>
Control	399.54	198.58	29.28
Experimental	518.17	182.493	26.91

**Table 6: Independent Samples T-Test Combined Difference in Mean of Pre- to Post-Test for All Computer Literacy Test Instruments**

<b>Independent Samples T-Test (Combined Difference in Mean of Pre- to Post-Test for All Computer Literacy Test Instruments)</b>				
Computer Literacy Pre- to Post-Test difference (combined)	F	t	df	Sig (2-tailed)
	1.266	-2.983	90	.004

When performing independent t-test analysis on the difference between the pre- and post-test scores for the critical thinking instrument, the results showed no significant difference between the experimental and control groups in critical thinking ( $t = -0.706$ ,  $p > 0.05$ ), (see Table 8). This indicates that students in the treatment group had no significant difference in overall knowledge of critical thinking compared to the control group. We are thus unable to reject the null hypothesis.

**Table 7: Group Statistics Mean of Pre- to Post-Test Difference for Critical Thinking Test Instrument**

<b>Group Statistics (Mean of Pre- to Post-Test Difference for Critical Thinking Test Instrument)</b>			
Group	Mean	Std. Deviation	Std. Error Mean
Control	-1.52	7.477	1.102
Experimental	-0.48	6.686	0.986

**Table 8: Independent Samples T-Test Mean of Pre- to Post-Test Difference for Critical Thinking Test Instrument**

<b>Independent Samples T-Test (Mean of Pre- to Post-Test Difference for Critical Thinking Test Instrument)</b>				
Critical Thinking Pre- to Post-Test difference	F	t	df	Sig (2-tailed)
	0.559	-0.706	90	0.482

Drilling down further in the data, an independent t-test was performed on the differences between the pre- and post-test scores for each of the three computer literacy

instruments in isolation to see if each was individually statistically significantly impacted by the treatment and if so by what degree. This is especially important because the computer literacy pre- and post-test were administered during various stages of the class: the Computing Fundamentals pre-test is given during the first week of class, the Computing Fundamentals post-test and the Key Applications pre-test is administered during the fourth week of class, the Key Applications post-test and Living Online pre-test are given during the tenth week of class, and the Living Online post-test are given during the fourteenth week of class.

When performing independent t-test analysis on the difference between the pre- and post-test scores for the Computing Fundamentals exam, the results showed no significant difference between the experimental and control groups in overall achievement on the Computing Fundamentals exam,  $t = -0.651$ ,  $p > 0.05$ , (see Table 10). This indicates that students in the treatment group had no significant difference in overall achievement on the Computing Fundamentals exam when compared to the control group. We are thus unable to reject the null hypothesis.

**Table 9: Group Statistics Mean of Pre- to Post-Test Difference for Computing Fundamentals Test Instrument**

<b>Group Statistics (Mean of Pre- to Post-Test Difference for Computing Fundamentals Test Instrument)</b>			
<b>Group</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Std. Error Mean</b>
Control	154.00	112.580	16.599
Experimental	168.15	95.164	14.031

**Table 10: Independent Samples T-Test Mean of Pre- to Post-Test Difference for Computing Fundamentals Test**

Independent Samples T-Test (Mean of Pre- to Post-Test Difference for Computing Fundamentals Test Instrument)				
Computing Fundamentals Pre- to Post-Test difference	F	t	df	Sig (2-tailed)
	0.130	-0.651	90	0.517

When performing independent t-test analysis on the difference between the pre- and post-test scores for the Key Applications exam, the results showed a significant difference between the experimental and control groups in overall achievement on the exam,  $t = -2.178$ ,  $p < 0.05$ , (see Table 12). This indicates that students in the treatment group had a significant difference in achievement on the Key Applications exam when compared to the control group, thus rejecting the null hypothesis. Furthermore, an estimate for the effect size for the independent-samples t-test can be calculated by using the following formula for Eta squared (Pallant, 2007, p. 236):

$$\text{Eta squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)}$$

$$\text{Eta squared} = \frac{-(2.178)^2}{-(2.178)^2 + (46 + 46 - 2)}$$

$$\text{Eta squared} = .05$$

This indicates a moderate effect of the treatment on the improved outcomes in Key Applications proficiency in the experimental group, with approximately 5% of the variance in scores being explained by the treatment.

**Table 11: Group Statistics Mean of Pre- to Post-Test Difference for Key Applications Test**

<b>Group Statistics (Mean of Pre- to Post-Test Difference for Key Applications Test Instrument)</b>			
Group	Mean	Std. Deviation	Std. Error Mean
Control	211.33	108.200	15.953
Experimental	257.30	93.728	13.820

**Table 12: Independent Samples T-Test Mean of Pre- to Post-Test Difference for Key Applications Test**

<b>Independent Samples T-Test (Mean of Pre- to Post-Test Difference for Key Applications Test Instrument)</b>				
Key Applications Pre- to Post-Test difference	F	t	df	Sig (2-tailed)
	0.351	-2.178	90	0.032

When performing independent t-test analysis on the difference between the pre- and post-test scores for the Living Online exam, the results showed a significant difference between the experimental and control groups in overall achievement on the exam,  $t = -2.988$ ,  $p < 0.05$ , (see Table 14). This indicates that students in the treatment group had a significant difference in achievement on the Living Online exam when compared to the control group, thus rejecting the null hypothesis.

Furthermore, an estimate for the effect size for the independent-samples t-test can be calculated by using the following formula for Eta squared (Pallant, 2007, p. 236):

$$\text{Eta squared} = \frac{t^2}{t^2 + (N1 + N2 - 2)}$$

$$\text{Eta squared} = \frac{-(2.988)^2}{-(2.988)^2 + (46 + 46 - 2)}$$

$$\text{Eta squared} = .09$$

This indicates a moderate to large effect of the treatment on the improved outcomes in Living Online content proficiency in the experimental group, with approximately 9% of the variance in scores being explained by the treatment.

**Table 13: Group Statistics Mean of Pre- to Post-Test Difference for Living Online Test**

<b>Group Statistics (Mean of Pre- to Post-Test Difference for Living Online Test Instrument)</b>			
Group	Mean	Std. Deviation	Std. Error Mean
Control	34.22	97.368	14.356
Experimental	92.72	90.257	13.308

**Table 14: Independent Samples Test Mean of Pre- to Post-Test Difference for Living Online Test**

<b>Independent Samples Test (Mean of Pre- to Post-Test Difference for Living Online Test Instrument)</b>				
Living Online Pre- to Post-Test difference	F	t	df	Sig (2-tailed)
	0.232	-2.988	90	0.004

## **Qualitative Analysis**

### *Focus Group with Experimental Group Instructors*

A focus group interview was conducted with the three instructors that taught the experimental sections of the ISYS 110 course during the week following the end of the semester. The questions were intended to learn what the instructors felt worked well in the course, what they felt did not work well, and what changes they perceived in students that might not have been determined by pre- and post-test scores.



The interview took place in an informal setting (researcher's office) and was recorded with the permission of the interviewees. The questions and answers of this interview are transcribed below.

**Q: In your opinion, what was the students' overall reaction to adding critical thinking instruction to their course?**

**A's: Instructor 1:** "In the beginning it was very new and they didn't know what to expect."

**Instructor 2:** "By the end of the course, they became more confident and comfortable with both an understanding and application of critical thinking, but more so with the ability to apply it."

**Q: What observations led you to reach the above conclusions?**

**A's: Instructor 2:** "The interaction of the groups during the critical thinking exercises that were part of the experimental group format."

**Instructor 3:** "Initially, students were tentative because they didn't understand basic critical thinking concepts well enough, but as we began to apply them, they realized the value in doing so and they became more aware of their own thinking."

**Q: How do you feel adding critical thinking to the computer literacy course impacted student learning?**

**A's: Instructor 3:** "It improved student engagement."

**Instructor 1:** "Because so much of computer literacy is learning to solve problems, the critical thinking model gave students the framework and reasoning skills to do this."

**Instructor 3:** “In one class, 100% of students achieved certification on the 2<sup>nd</sup> exam, the one requiring the greatest degree of higher level thinking ability, something that has never happened before.”

**Q: Do you feel there were students who suffered because of the introduction of computer literacy concepts?**

**A's:** Everyone agreed that all the students benefited from the critical thinking approach.

**Q: What do you feel worked best in the class or was most beneficial?**

**A's: Instructor 1:** “The critical thinking group exercises became a framework to integrate the computer literacy concepts into the students’ thinking and they became a structure upon which to base lectures and classroom discussion.”

**Instructor 3:** “It helped transform the class into a more cohesive unit which in turn better supported collaborative learning.”

**Q: What in the class do you feel did not work well?**

**A's: Instructor 2:** “It was difficult to find the time to focus on teaching the critical thinking model in a standalone manner. It worked better to teach them while integrating them into the actual curriculum.”

**Instructor 3:** “The critical thinking test was not seen as being part of the course requirement, so students were not motivated to perform at their best.”

**Q: What student comments did you get that indicated student reactions to the class, either positive or negative?**

**A's: Instructor 1:** “There were no negative comments. Those that commented expressed the positive impact the class had on their ability to be more successful on the certification exams.”

**Instructor 2:** “Students began to acknowledge how their improved critical thinking could and was impacting other areas of their lives in a positive way.”

**Q: Did teaching the class using a critical thinking approach change the experience of teaching the class for you as the instructor in a positive or negative way?**

**A’s: Instructor 3:** “Initially it was more difficult because it was different, but toward the end it was more enjoyable because of the increased interaction and being able to witness students’ improvements.”

**Q: What suggestions do you have to improve the course if critical thinking was added to the curriculum in the future?**

**A’s: Instructor 3:** “Instructors need more training in critical thinking.”

**Instructor 2:** “The institution must embrace the value of teaching critical thinking.”

**Instructor 1:** “Perhaps it would be helpful to offer a short term critical thinking stand-alone course in the elements as a foundational course prior to infusing it into later classes.”

## **Discussion**

While the quantitative findings showed no significant differences between the treatment and control groups in improvement of critical thinking skills during the course of one semester, statistically significant improvements in performance in the area of computer literacy were noted. Students in the treatment group had higher computer literacy knowledge at post-test compared to the control group.

The findings of this study indicated that teaching introductory computer courses using Richard Paul’s model for critical thinking could improve computer literacy knowledge of students. Of particular note was the observance that this impact on student

performance increased throughout the duration of the course, from a non-detectible effect at the earlier stages of the course to a statistically significant effect by the end of the course with 9% of improvement in performance being attributed to the treatment.

While the quantitative analysis did not uncover any statistically significant evidence of improvements in critical thinking, qualitative analysis in the form of instructor focus groups indicated an awareness of students' improved ability in problem solving and reasoning.

## **CHAPTER 5**

### **CONCLUSIONS AND IMPLICATIONS**

#### **Introduction**

The main purpose of this study was to determine how higher education can best develop students' abilities in computer literacy and critical thinking, and whether teaching both simultaneously was good practice or at least held promise to become such with future research. This topic is both relevant and crucial, since computer literacy and the ability to think critically have both been identified as essential skills of graduates entering a 21<sup>st</sup> century workforce (Jerald, 2009).

In spite of a relatively universal consensus regarding the importance of teaching students these competencies, there is still both a general lack of research concerned with how students best learn critical thinking and computer literacy skills as well as a resulting widespread disagreement about the best way to teach them. Furthermore, at the core of this disagreement lies the inability to even reach concurrence regarding what actually constitutes computer literacy and critical thinking.

The purpose of this study therefore was to build on the small amount of related literature by conducting a research-based study to examine the effectiveness of infusing

critical thinking into the curriculum of a computer literacy course lasting one semester. Richard Paul's model of critical thinking was chosen from among several general critical thinking models for investigation in this study because of its rich theoretical foundation, its flexibility and its applicability to a wide range of circumstances requiring good reasoning (Foundation for Critical Thinking, 2011). Furthermore, Richard Paul is an internationally recognized leader in critical thinking who founded the Foundation for Critical Thinking (FCT) in 1981. His theoretical framework is highly regarded by others in the critical thinking field, both theoreticians as well as researchers.

To determine the effectiveness of teaching computer literacy by infusing critical thinking into the curriculum, the researcher attempted to answer the following questions:

1. Will a group of community college students who receive explicit training in computer literacy concepts using a critical thinking approach perform better on a computer literacy test that requires the application of analysis and reasoning than a group of similar students not receiving explicit instruction in critical thinking?
2. How can critical thinking skills be infused into computer literacy instruction to best improve student performance in both areas?
3. Can the teaching of computer literacy using a critical thinking approach improve critical thinking skills in a single course over the course of one semester, and, if so, to what degree can this occur?

This chapter will examine and discuss the results of the study as they relate to these research questions. It will also assess the limitations of the study, consider possible implications for application, and make recommendations for areas of future research.

### **Research Questions**

#### *Question #1: Improved Performance on Computer Literacy Tests for Treatment Group?*

This question assessed the effect of infusing a critical thinking approach, specifically Richard Paul's model, into a computer literacy class over the course of one semester in making statistically significant improvements in students' abilities to perform well on tests measuring their computer literacy aptitude.

To address this question, the researcher integrated Paul's model for critical thinking into the experimental sections by providing a special lesson plan for instructors, focusing on activities that encourage active learning, having students sign a Student Understanding Form making them explicitly aware of the nature of the course and the expectations for their involvement, giving students a Critical Thinking Packet to explain the definition and nature of critical thinking as well as to explicitly teach elements of Paul's model, giving students a special course syllabus emphasizing the unique nature of the course, and giving assignments that required students to use the model to think critically within the discipline of computer literacy. With the exception of the critical thinking component for the experimental group, all sections in the study participated in the same activities, and were taught in the same manner.

To test the effectiveness of the model in teaching students computer literacy, students in both groups were given Certiprep's three IC<sup>3</sup> exams: Computing Fundamentals, Key Applications, and Living Online. These exams require students to use

analytical and critical thinking skills to answer several problem-based questions related to computer literacy.

The pre- and post-test scores on these exams for the control and experimental groups in the study served as the data for determining if students taught to use Paul's model were better able to perform like computer literate individuals than students who were not trained using a critical thinking approach.

Data was analyzed by first running an independent-sample t-test on the pre-test scores for each of the three IC<sup>3</sup> exams between the control group and the experimental group. The results indicate no statistically significant difference between the groups in computer literacy before the initiation of the study (computing fundamentals,  $t = -0.663$ ,  $p > 0.05$ , key applications,  $t = 1.605$ ,  $p > 0.05$ , and living online,  $t = 1.679$ ,  $p > 0.05$ ).

An independent-sample t-test was then performed on pre- to post-test differences between the control and experimental groups for the combined score on all three exams. The results showed a significant difference between the experimental and control groups in computer literacy,  $t = -2.983$ ,  $p < 0.05$ . This indicates that students in the group receiving the treatment had a higher overall knowledge of computer literacy compared to the control group, thus rejecting the null hypothesis. Furthermore, an estimate for the effect size for the independent-samples t-test was calculated using the formula for Eta squared (Pallant, 2007, p. 236). This indicated a moderate to large effect of the treatment on the improved outcomes in computer literacy in the experimental group, with approximately 9% of the variance in computer literacy scores being explained by the treatment.



An independent-sample t-test was then run on the pre- to post-test differences for each individual IC<sup>3</sup> exam. When performing independent t-test analysis on the difference between the pre- and post-test scores for the Computing Fundamentals exam, the results showed no significant difference between the experimental and control groups in overall achievement on the Computing Fundamentals exam,  $t = -0.651$ ,  $p > 0.05$ . This indicated that students in the treatment group had no significant difference in overall achievement on the Computing Fundamentals exam when compared to the control group. We were thus unable to reject the null hypothesis.

When performing independent t-test analysis on the difference between the pre- and post-test scores for the Key Applications exam, the results showed a significant difference between the experimental and control groups in overall achievement on the exam,  $t = -2.178$ ,  $p < 0.05$ . This indicated that students in the treatment group had a significant difference in achievement on the Key Applications exam when compared to the control group, thus rejecting the null hypothesis. Furthermore, an estimate for the effect size for the independent-samples t-test was calculated by using the formula for Eta. This indicates a moderate effect of the treatment on the improved outcomes in Key Applications proficiency in the experimental group, with approximately 5% of the variance in scores being explained by the treatment.

Finally, when performing independent t-test analysis on the difference between the pre- and post-test scores for the Living Online exam, the results showed a significant difference between the experimental and control groups in overall achievement on the exam,  $t = -2.988$ ,  $p < 0.05$ . This indicated that students in the treatment group had a

significant difference in achievement on the Living Online exam when compared to the control group, thus rejecting the null hypothesis.

Furthermore, an estimate for the effect size for the independent-samples t-test was calculated by using the formula for Eta squared. This indicated a moderate to large effect of the treatment on the improved outcomes in Key Applications proficiency in the experimental group, with approximately 9% of the variance in scores being explained by the treatment.

There was an increasing disparity of performance between the control and experimental groups throughout the duration of the course from no apparent effect at the earliest stage to a 5% effect of the treatment in the experimental group after the Key Application exam (about halfway through the semester) to an overall statistically significant effect by the end of the course with 9% of improvement in performance being attributed to the treatment.

This seems to answer affirmatively the first research question as to whether infusing critical thinking concepts into a computer literacy course can lead to statistically significant improvements in performance. Furthermore, it appears that students learn to think critically over time just like the learning of any skill, and that as time passes they have both an increased ability and confidence in using this ability. Finally, this research indicates that one semester appears to be long enough to make significant improvements in students capacity to apply critical thinking to the discipline of computer literacy, at the same time implying that a continuation of this critical thinking approach throughout the academic experience would further this aptitude.

*Question #2: Best Method for Infusing Critical Thinking Skills into a Computer Literacy Curriculum?*

Richard Paul's model for critical thinking (Foundation for Critical Thinking, 2011) was used as the basis for the experimental treatment in this study. Paul's model includes elements of reasoning, universal intellectual standards used to assess student reasoning, and traits or virtues of the reasoning mind. It is a general model of reasoning that can be applied to any problem or issue requiring reasoning, and was therefore chosen because it incorporates critical thinking standards and because its flexibility allows it to be integrated into any academic content and has the additional benefit of being valuable for thinking about both academic subjects as well as everyday issues.

In their book, *A Miniature Guide for Those Who Teach on How to Improve Student Learning: 30 Practical Ideas*, critical thinking experts Richard Paul and Linda Elder (2007) offer several useful strategies for infusing critical thinking into instruction, many of which were implemented in the experimental group for this study.

As stated above, to address this question, the researcher integrated Paul's model for critical thinking into the experimental sections by (a) providing a lesson plan for instructors (Appendix B) stressing making students explicitly aware of what was expected of them in the course, and focusing on activities that encourage active learning, (b) having students sign a Student Understanding Form (Appendix C), again making them explicitly aware of the nature of the course and the expectations for their involvement, (c) giving students a Critical Thinking Packet (Appendix D) to explain the definition and nature of critical thinking as well as to explicitly teach elements of Paul's model, (d) giving students a special course syllabus emphasizing the unique nature of the

course (Appendix E), and (e) giving assignments that required students to use the model to think critically within the discipline of computer literacy.

Students in the control group used the same textbook and read the same assignments as students in the experimental group, but they were not given the critical thinking packets, or asked to complete the critical thinking assignments, nor were they taught to apply Richard Paul's model for critical thinking within the discipline of computer literacy. As previously stated, with the exception of the critical thinking component for the experimental group, all sections in the study participated in the same activities, and were taught in the same manner.

In an attempt to determine whether the above techniques were the "best methods" for infusing critical thinking into a computer literacy course, the results were mixed. While, as stated in the previous section, the improvements in computer literacy outcomes made during the course of the semester in the experimental group were significant and can be attributed to the critical thinking strategies implemented, more research would be needed to determine which strategies had the greatest impact.

Furthermore, as will be revealed in the next section, results from statistical analyses of the scores on the *International Critical Thinking Basic Concepts and Understandings Test* measuring students' critical thinking ability showed no significant differences between the experimental and control groups. Consequently, while we can conclude that the techniques used in the experimental group somehow impacted students' ability to better learn and apply computer literacy concepts, students did not make quantifiable gains in their critical thinking knowledge/ ability.

*Question #3: Computer Literacy Using a Critical Thinking Approach to Improve Critical Thinking Skills?*

This question considers the effect of infusing a critical thinking approach, specifically Richard Paul's model, into a computer literacy class over the course of one semester in making statistically significant improvements in students' abilities to perform well on tests measuring their critical thinking aptitude. To address this question, the researcher integrated Paul's model for critical thinking into the experimental sections, as stated in the section above.

To test the effectiveness of the model in teaching students critical thinking, students in both groups were given the International Critical Thinking Basic Concepts and Understandings Test.

Data was analyzed by first running an independent-sample t-test on the pre-test scores for the exam between the control group and the experimental group. The results indicate no statistically significant difference between the groups in critical thinking before the initiation of the study ( $t = -1.332, p > 0.05$ ).

An independent-sample t-test was then performed on the pre- to post-test difference between the control and experimental groups for the score on the International Critical Thinking Basic Concepts and Understandings Test. The results again showed no significant difference between the experimental and control groups in critical thinking ( $t = -0.706, p > 0.05$ ). Consequently, it seems that taking a single computer literacy course during a single semester that included the elements of critical thinking included in the experimental group in this study had no effect on students' dispositions toward critical thinking. However, while the quantitative analysis did not uncover any statistically

significant evidence of improvements in critical thinking, qualitative analysis in the form of instructor focus groups did seem to indicate an awareness of students' improved ability at better problem solving and reasoning.

There may be many reasons for the lack of critical thinking improvement in the experimental group, at least as measured in a quantitative sense. First of all, the *International Critical Thinking Basic Concepts and Understandings Test* is still a relatively new test instrument. There is very little research indicating its ability to measure gains in critical thinking dispositions during the course of a single semester. This, however, in no way indicates that its conclusions in this study are not accurate. There are in fact more likely causes for the lack of critical thinking improvements.

For instance, a potential cause of lack of improvement in critical thinking as indicated by the test scores could be a lack of student motivation to perform well. Participants in the experimental group were told to perform their best on the pre- and post-test measuring critical thinking, but they were aware that their actual scores would not affect their final grade in the class. The post-test specifically was administered at the end of the semester and students were asked to take time during their busy schedule to complete a task that had no effect on their final course grade. This researcher is left to wonder how seriously some of the participants took doing their best on the assessment. This is in contrast with the pre- and post-tests for computer literacy for the course that counted very heavily toward their final grade and that students seemed to take very seriously.

Finally, it may be simply unreasonable to assume that students would be able to make significant gains in critical thinking ability during a single semester, especially in a

course that is geared toward the teaching of other content entirely. While the teaching of critical thinking seems to have enhanced the learning of computer literacy, the focus on the course discipline itself may have been too much of a distraction to make significant gains in critical thinking as well during a single semester. More than one semester of instruction and practice in critical thinking skills may be necessary in order to either improve students' scores on the *International Critical Thinking Basic Concepts and Understandings Test* or simply improve critical thinking dispositions in general. This has implications that will be discussed later in this chapter.

To summarize these conclusions:

- When infusing critical thinking into the curriculum, community college students are able to significantly improve computer literacy skills in a single course.
- Infusing Richard Paul's model of critical thinking into a computer literacy course made a significant improvement in students' abilities on a computer literacy assessment. Specifically, by making expectations clear for students, explicitly teaching the model of critical thinking, and promoting active learning through the interaction of the material utilizing critical thinking concepts, students were better able to learn computer literacy.
- Infusing Richard Paul's model of critical thinking into a computer literacy class over a single semester seems to have no effect on students' abilities to think critically, at least as assessed by the *International Critical Thinking Basic Concepts and Understandings Test*. Several potential explanations for this finding were discussed above.

## **Limitations**

### *Generalization to other Populations*

The results of this study pertain to the population described and cannot be generalized to the total population of college students or even to all community college students. While the research participants were characteristic in many ways of students in many community colleges, the subjects in the study were limited to students at a single small, rural Midwestern community college who had not yet taken a computer literacy/skills course at the post-secondary level.

As such, the findings from this study cannot be generalized to other students of other levels or at other colleges. A different demographic might in fact create different results from those presented here. Also, while the sample size was fairly large ( $n = 92$ ,  $N = 286$ ), replication of this study with other populations both at the institution under study and other institutions would help strengthen these findings.

### *Generalization to other Disciplines*

In addition, the subject under study was on critical thinking instruction as it relates to computer literacy and as such, the study findings cannot be generalized to other disciplines in the curriculum. In addition, the results of this study are specific to the method of infusing Richard Paul's model into computer literacy courses as described in this study. Consequently, using a different strategy to introduce Paul's model into computer literacy courses, or infusing Paul's model into other academic disciplines, may produce different results. More research is obviously needed to determine the generalizability of these findings.



### *Critical Thinking Test Instrument*

Another possible limitation of this study was the assessment instruments, especially those testing critical thinking. While the researcher chose the instrument that seemed most appropriate given the nature of the study, there is no way to determine definitively if the chosen instrument adequately measured students' gains in critical thinking skill and dispositions, or if a different instrument would have been more sensitive to the changes made during the course of the study.

### *Instructor Training*

Finally, the degree of instructor training required to successfully infuse Paul's model into the experimental courses may be another limitation of this study. While the instructors for this study participated in training in Paul's model, more intensive training may have led to different results.

## **Implications for Practice**

### *Improved Ability to Think Within a Discipline, Especially Computer Literacy*

This study was conducted in a traditional community college setting. Findings revealed a statistically significant improvement in performance and a moderately large effect size on instruments testing computer literacy. This implies that teaching Paul's model can improve students' ability to think within a discipline, specifically in the area of computer literacy. This also indicates that infusing Paul's model into other disciplines or across the educational curricula in general could lead to similar positive educational outcomes.

### *Potential for Gains in Critical Thinking*

While the results of this study did not show statistically significant differences

between the control group and the experimental group in differences on pre- to post-test critical thinking performance, qualitative analysis seems to indicate otherwise.

Therefore, this researcher believes that further research has the potential to demonstrate educational approaches leading to students' gains in critical thinking skills and dispositions, especially with further research.

As stated earlier, in an analysis of pre- to post-test critical thinking scores, the lack of statistical significance may be a result of an inappropriate test instrument, the structure of the course itself, or simply the fact that the duration of the study may be too short to achieve measureable gains in critical thinking. But the moderately high effect on computer literacy scores would at least imply that students' reasoning is increasing at a significant rate. This would suggest that further research into methods of infusing Paul's model into a single computer literacy course or, alternatively, over several courses across the curricula could lead to statistically measureable gains in critical thinking.

#### *Institution-Wide Comprehensive Critical Thinking Approach*

The results of this study also suggest that in order for Paul's model to be successfully integrated into course content, instructors must receive sufficient training and support. Just as students cannot be expected to incorporate these higher order thinking skills without an adequate amount of education and practice, instructors too will need to become "students" of the model and integrate it into their teaching methodology. This process does not happen overnight. Rather it is an approach to instruction that requires openness to reassessing one's teaching philosophies and subsequently redesigning course content to reflect these new fundamentals.

The Foundation for Critical Thinking provides training in the model during

yearly Spring Workshops and an annual International Conference. Handbooks, or *Thinker's Guides* as they are known, outline much of what is presented during training and also provide specific guidelines for incorporating the model into the structure of the curriculum.

Basic training in the principles and practical applications of the model must be followed up with ongoing dedicated training in other aspects of the critical thinking model that will continue to expand on its essential features. For example, specialized sessions on Socratic questioning or content-driven and question-driven instruction and others like it will continue to enhance the teaching methodology of an instructor who has already mastered and integrated the basics of the model. In this researcher's opinion, in order for an institution to enact a comprehensive approach to teaching critical thinking, it must commit to a comprehensive approach to ongoing training of faculty in the application of critical thinking principles.

#### *Rethinking the Computer Literacy Teaching Approach*

The results of this study suggest that there exist ways to rethink how computer literacy is currently being taught at the post-secondary level. Specially, computer literacy can no longer be reduced to simply knowing computer terminology or how to operate a computer based on rote memorization. True computer literacy must embrace making use of computers to solve problems. This study presents one such post-secondary computer literacy course model with this objective, focusing on problem solving using computers, and encouraging methodological thinking using a critical thinking approach.

### *Teaching Critical Thinking Across the Curriculum*

The fact that statistically significant gains in critical thinking were not demonstrated in this study implies that one semester and one course may be insufficient to lead to measurable students' gains in critical thinking skills and dispositions. This coupled with the essential need for students to learn foundational critical thinking skills for success both academically and in the workplace indicates a need to teach critical thinking across the curriculum by infusing it throughout the educational experience both at the secondary and post-secondary level and in many disciplines.

Integrating the model at various educational stages would allow students to develop their critical thinking abilities gradually over time, and continue to build on this knowledge, achieving more and more sophisticated levels of understanding and application. This higher order thinking ability is essential for achieving many of the main objectives of our educational system including academic excellence, an educated society, and a capable workforce able to compete globally.

### **Recommendations for Future Research**

First and foremost, because this study took place during one semester at one relatively small rural community college in the Midwest, the findings can be greatly strengthened by replicating this study during another semester at the same institution, at other schools (both universities and community colleges that currently have computer literacy programs), and at schools of different sizes and demographics located in a variety of regions.

The ultimate goal in computer literacy and critical thinking education is to develop students that will be able to carry these skill sets into their academic career and

ultimately into the workforce. One potential area for research, therefore, is to perform a longitudinal study on students who participated in this study to see if the students taught computer literacy using Paul's model retain the critical thinking abilities they gained and if they are more likely to maintain a higher level of computer literacy ability than those in the control group.

In addition, though the findings of this study indicate significant improvements from infusing Paul's model into a computer literacy curriculum, future research should be conducted at different grade levels as well as in a variety of subject matter to determine if teaching using Paul's model in these other settings has equally significant outcomes. Furthermore, research needs to be done to see if other critical thinking models might be equally effective at achieving improved learning outcomes.

There are many critical thinking test instruments, including the *California Critical Thinking Skills Test (CCTST)*, the *Watson Glaser Critical Thinking Test*, the *Cornell Critical Thinking Test*, and the one used in this study, the *International Critical Thinking Basic Concepts and Understandings Test*. All test instruments undoubtedly have their strengths and weaknesses, so research should be conducted testing Paul's method using other assessment instruments.

Considering the broader implications, educational institutions need to take seriously the gravity of integrating computer literacy and critical thinking core requirements into the curriculum in order to produce graduates prepared for the 21<sup>st</sup> Century world that we live in. This will require making research-based decisions regarding how these foundational skills should be taught, and the setting of institutional policies about how best to carry out a comprehensive strategy for successfully meeting

these established educational goals.

### **Recommendations for Institutional Change**

Teaching students computer literacy and how to think critically are not simple tasks. The first step is admitting that the majority of students, whether or not they have grown up in a technological world, enter post-secondary education without these basic foundational skills necessary for academic and workplace success.

Educators must also admit that the current educational system is falling short in preparing these students for an increasingly complex world. The solution to fixing this system must be a comprehensive one in which we find new research-based approaches to teaching computer literacy and infusing critical thinking throughout the curriculum.

Teaching critical thinking is not easy, and there is no magic bullet or secret formula that can effectively deal with the complexity of the task. However, if institutions are serious about undertaking this essential task, they must redefine their philosophy of education. The traditional lecture-based one-way communication model with the passive learner is no longer viable. One way to go about making this institutional change is for educators to become “students” of this new way of teaching.

This requires not only initial training to teach for critical thinking but also a commitment for instructors to receive ongoing support as they learn to think more critically about the content of their courses and the approach they use to teach them. Changing course materials and methods so that students are challenged to think critically requires a significant amount of time and effort. As a result, instructors will need to be appropriately compensated and receive institutional support to successfully implement this model on a comprehensive scale. While this undertaking is not without its

difficulties, it is simply the right thing to do for higher education, the students we serve, and the society we are preparing them for.

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**APPENDIX A**

**ISYS 110 INSTRUCTOR SURVEY**

## ISYS 110 INSTRUCTOR SURVEY

- 1. From your experience, please rate the average student enrolled in the ISYS 110 class in their ability to do the following (circle one number for each row):**

Read a problem and decide how to begin attacking it	5	4	3	2	1	Cannot settle on a way to begin.
Bring their knowledge to bear on a problem.	5	4	3	2	1	Convince themselves they lack sufficient knowledge (even when that is not the case).
Go about solving a problem systematically—for example, trying to simplify it, puzzling out key terms, or breaking the problem into subproblems	5	4	3	2	1	Plunge in, jumping haphazardly from one part of the problem to another, trying to justify first impressions instead of testing them
Tend to trust their reasoning and to have confidence in themselves	5	4	3	2	1	Tend to distrust their reasoning and to lack confidence in themselves
Maintain a critical attitude throughout the problem-solving process	5	4	3	2	1	Lack a critical attitude and take too much for granted

*Adapted from Ruggiero (2009, p. 12)*

- 2. Rank in order of importance (with 1 being most important and 5 being least) the reasons that you feel students may be unsuccessful in the ISYS 110 course.**

\_\_\_\_\_ Poor study skills

\_\_\_\_\_ Poor critical thinking skills

\_\_\_\_\_ No background in using computers

\_\_\_\_\_ Lack of motivation

\_\_\_\_\_ Underestimating the difficulty of the class

**3. Do you believe that teaching students how to thinking critically (i.e. helping them to clarify concepts, reason through problems, etc.) could improve their performance in ISYS 110?**

\_\_\_\_\_ Yes    \_\_\_\_\_ No

**Why or why not?**

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**APPENDIX B**

**LESSON PLAN FOR INSTRUCTORS**

## Lesson Plan for Instructors

### Introduction

In their book, *A Miniature Guide for Those Who Teach on How to Improve Student Learning: 30 Practical Ideas*, critical thinking experts Richard Paul and Linda Elder (2007) offer several useful strategies for infusing critical thinking into instruction, many of which will be implemented for the class that you will be teaching as part of this study.

While you will be teaching this course in the much the same way you have been teaching the course thus far (reading assignments, quizzes, skill drills, practices test), you will also be infusing a critical thinking component by incorporating the strategies listed above.

### Class Orientation

Many of the strategies are simply making students more aware of expectations for the course, in particular their own accountability for learning.

- A **special syllabus** has been developed for this course which highlights expectations for students (Paul & Elder, 2007, p. 16).
- A “**student understanding” form** has also been developed for this course. This form will be given to students during the orientation to the course, with an explanation of each item. Students will then initial each item as you explain it, indicating their under-standing (Paul & Elder, 2007, p. 24).
- You will **give students a thorough orientation to the course**, emphasizing how it will be taught, how they will be assessed, and what they should be striving to achieve. In addition, you should begin the course with something like the following introduction:

*This class is going to be different from any class you have taken thus far because the emphasis will be on actively developing your thinking. Everything we do in this class will be designed to help you become better at thinking within the subject of computer literacy. You will therefore not be asked to memorize information rotely. Instead, you will be required to internalize*

*information by using it actively in every class and in class assignments. Each day we will be attempting to improve your thinking. Think of learning about thinking (within the subject of computer literacy) as you would of learning a sport. To learn to play tennis, you need to first learn the fundamentals of tennis at an elementary level and then practice those fundamentals during every practice session. The same is true of learning to think better with this subject. You must be introduced to the fundamentals of sound thinking. Then you must regularly practice those fundamentals. Therefore I will design every class with the primary purpose of helping you develop your thinking or reasoning skills. Why is this important? The quality of every decision you make will be directly determined by the quality of your reasoning abilities. In fact, the quality of your life in general will be determined by how well you think in general.*

- **Explain the key concepts of the course explicitly during the first couple of class meetings** (Paul & Elder, 2007, p. 26). It is helpful to students from the beginning of the course if they are clear about the key or “organizing ideas” of the course. “This is the foundational or guiding concept underlying everything you will be teaching in a given course.” For purposes of the ISYS 110 class, this foundational and guiding concept is the following: “We will focus in this class on thinking critically as a computer literate individual with the ability to apply these skills in your personal, workplace, and academic lives.”
- **Explain to the students, when orienting them to the class, what will happen on a typical class day (and why)** (Paul & Elder, 2007, p. 25). A typical day in class should encourage ample opportunity for student engagement in active learning. Designing a typical class day so that students are required (by the design) to be actively and thoughtfully involved is important. Here is a possible format you might want to use in creating your “typical day”:

1. At the end of each class period, assign some section from the textbook for students to read.
  2. Where possible, ask students to write out their answers to key questions within those sections.
  3. When students come to class on the next day, place them in pairs or triads.
  4. Have each student read his/her paper aloud to the group.
  5. As the student is reading his or her paper aloud, have the other students in the group give the reader feedback on his paper, focusing on two or three intellectual standards such as clarity, relevance, depth.
  6. Then lead a brief discussion of the chapter or section you are focused on, using an engaged lecture format or Socratic dialogue.
  7. At the end of the class period, assign another section for the students to read and on the next class day begin this process again.
- **Explain that class time will be a time in which the students will PRACTICE thinking (within the content) using the fundamental concepts and principles of the field**
    1. Approach every class session with a clear sense of the relevant thinking you are looking for in the students.
    2. Be prepared to model or dramatize (in front of the students) the thinking you want
    3. Design activities so that students both generate and assess thinking (Paul & Elder, 2007, p. 27).

The syllabus and student understanding form will be provided to you as will specific guidelines as to how to properly orient students to the course. Therefore these six strategies will be accomplished within the first week or two of class.

### **Design Features and Daily Emphasis**

- **Systematically question students using a Socratic approach** (Paul & Elder, 2007, p. 42).  
Socratic questioning (Paul, Binker, Martin & Adamson, 1989, p. 25):
  - Raises basic issues



- Probes beneath the surface of things
  - Pursues problematic areas of thought
  - Helps students to discover the structure of their own thought
  - Helps students develop sensitivity to clarity, accuracy, and relevance
  - Helps students arrive at a judgment through their own reasoning
  - Helps students note claims, evidence, conclusions, questions-at-issue, assumptions, implications, consequences, concepts, interpretations, points of view: the Elements of Thought
- **Design instruction so that students engage in routine practice in internalizing and applying the concepts they are learning** (Paul & Elder, 2007). “For students to learn any new concept well they must initially internalize the concept, then apply the concept to a problem or issue so that they come to see the value of understanding the concept. At the same time, they need to evaluate how well they are internalizing and applying the concepts they are learning” (p. 4).
  - **Use engaged lecture** (Paul & Elder, 2007, p. 13). Call on students to state, elaborate, exemplify, and illustrate (in their own words) the most important points in a lecture or chapter in the textbook.
  - **Think of yourself as a coach** (Paul & Elder, 2007). “One of the most important qualities of the critical thinking teacher is the ability to “coach” students in thinking, to become *facilitators of learning* rather than “givers of information... The students should see the class principally as a place for active engagement in a disciplined performance. We in turn should be there on the sidelines coaching them, making sure they are performing as they should” (p.29).
  - **Encourage students to think – quite explicitly – about their thinking** (Paul & Elder, 2007). “Give them specific suggestions on how to go about it... You should point out to students the danger of relying on rote memorization and periodic cramming as a way to try to pass the course. You should tell the students on the first class day that thinking through the content is the key agenda in the course and that this task will be the business of the class” (p. 31).
  - **Relate content whenever possible to issues, problems, and practical situations in the lives of your students** (Paul & Elder, 2007). “If a student is to personally

value skilled thinking—and hence to strive to practice it unmotivated by a class or a grade—that student must discover the relevance of that thinking to his own life” (p. 33).

- **Use tactics that encourage active learning** (Paul & Elder, 2007, p. 35).

Use the following tactics during class to ensure that students are actively engaged in thinking about the content. They should be routinely called upon to:

- Summarize in their own words what the teacher or a fellow student has said
  - Elaborate on what has been said.
  - Give examples to clarify or support what they have said.
  - Make connections between related concepts.
  - Restate the instructions or assignment in their own words.
  - State the question at issue.
  - Write down the most pressing issue on their mind at this point. The instructor then uses the above tactics to help students reason through the questions.
  - Discuss any of the above with a partner and then participate in a group discussion facilitated by the instructor.
- **Routinely ask questions that probe student understanding of the content** (Paul & Elder, 2007). “Calling on students need not be intimidating. It can be done in a ‘non-threatening’ fashion. Students then come to accept it as part of the process of learning...When we introduce students to this method, we remind them that we are concerned with the development of their thinking, and that we are not using this approach to intimidate them or make them appear ignorant in front of their friends. We then explain the purpose of this process—which is of course to help them improve their critical listening abilities to be more effective listeners” (p. 36).
  - **Model skilled thinking for your students** (Paul & Elder, 2007). “It is most likely the case that students are unaware of what highly skilled thinking looks like...Rather than just thinking well in front of students, we advocate explicit

modeling of skilled ‘moves.’ This means not only thinking aloud in front of students, but also calling attention to the ‘moves’ you are making” (p. 37).

- **Bring intellectual standards into daily use** (Paul & Elder, 2007, p. 40).

“Intellectual standards are essential to the assessment of thinking. Most students cannot name a single standard they use to assess thinking. It is therefore important to bring intellectual standards into the daily classroom activities. One way to move in this direction is to routinely ask students questions that require them to apply intellectual standards to their thinking:

- I’m not clear about your position. Could you state it in other words?  
(**clarity**)
- Could you be more precise? (**precision**)
- How can we check to see if the information you are using is accurate?  
(**accuracy**)
- How is what you are saying relevant to the question on the floor?  
(**relevance**)
- Can you articulate how you have considered the complexities of the issue?  
(**depth**)
- Can you articulate other reasonable ways of looking at the issue? (**breadth**)
- Is there a more logical interpretation than the one you have articulated?  
(**logic**)
- Have you focused on the most significant issue in dealing with this problem? (**significance**)

**APPENDIX C**

**STUDENT UNDERSTANDING FORM**

## Student Understanding Form

1. I understand the standards in this course and that I am responsible for monitoring my own learning. \_\_\_\_\_
2. I understand that the class will focus on practice not on lecture. \_\_\_\_\_
3. I understand that this class is not about rote memorization. Instead, I will be required to internalize information by using it actively in every class and in class assignments. \_\_\_\_\_
4. I understand on a typical class day I will be working in a small group and that I will be responsible to take an active part in advancing the assigned work of the group. \_\_\_\_\_
5. I understand that I will be held regularly responsible for assessing my own work using criteria and standards discussed in class. \_\_\_\_\_
6. I understand that if at any time in the semester I feel unsure about my "grade," I may request an assessment from the professor. \_\_\_\_\_
7. I understand that if the assignment for the day is not completed, then I am not prepared to do the "in-class" work of the day and may be asked to leave. \_\_\_\_\_
8. I understand that the work of the course requires consistent classroom attendance and active participation. \_\_\_\_\_
9. I understand that if I work hard in this course, it has the potential to make me both computer literate and a better critical thinker. \_\_\_\_\_
10. I understand the basis of the final grade as follows: \_\_\_\_\_
  - Certification Exams (3): about 68%
  - Online quizzes: about 8%
  - Assigned Homework: about 8%
  - Practice Tests: about 8%
  - Active, Skilled Participation: about 8%

NAME (print & sign) \_\_\_\_\_

**APPENDIX D**  
**CRITICAL THINKING PACKET**

# Critical Thinking Packet

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This course emphasizes thinking critically about computer literacy in all course work, including assignments, class discussions, and exams. We are using as our general model the elements and intellectual standards of critical thinking developed by Richard Paul and the Foundation for Critical Thinking.

As you begin to learn the elements and standards of reasoning, they will be of help to you in every aspect of this course as well as in other academic and everyday circumstances requiring good reasoning. Therefore, if you put determined effort into learning and practicing these elements of critical thinking, you will improve in your abilities and dispositions (attitudes) toward thinking critically about textbooks, homework assignments, and exams, and you will become a better critical thinker in every area of life.

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This packet contains:

- Definitions of critical thinking
- A chart showing the elements of reasoning and universal intellectual standards
- Definitions of the elements of reasoning
- Steps to Assess Your Own Thinking
- A chart showing the intellectual standards
- Explanation of universal intellectual standards through questions you can ask yourself about your own thinking or that of others

## HOW TO USE THIS PACKET:

Refer to the chart on elements and standards often as you assess your own reasoning or the reasoning of others.

Use the explanations of elements and standards as often as needed to make sure you understand the various aspects of reasoning. As the elements and standards become more familiar to you, begin to examine how you use these intellectual traits in every aspect of your life and how successfully you are applying them as you develop the abilities you need to be a good critical thinker.

Use your developing critical thinking skills as often as possible in this class and in other course work at XXXXX College, and in everyday reasoning and decision making. The more you practice using these traits, the more skilled you will become as a critical thinker.

### **Selected Definition of Critical Thinking**

You might think of Critical Thinking as: “Thinking about your thinking while you’re thinking in order to improve your thinking.” (Richard Paul)

Critical Thinking can also be thought of as:

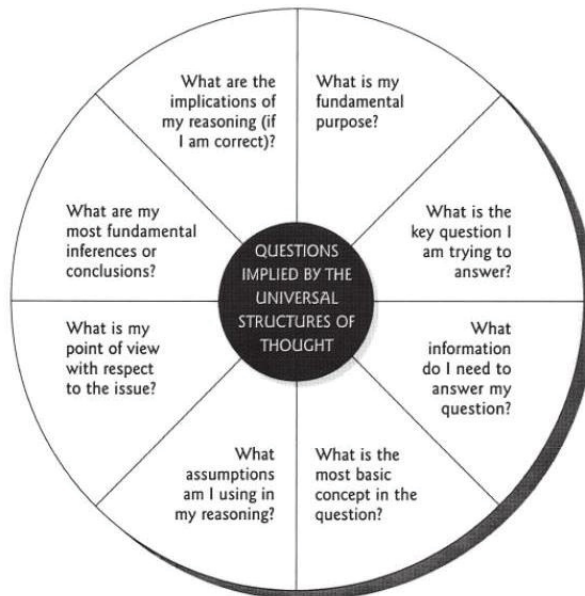
- “Reasonable, reflective thinking that is focused on deciding what to believe or do.”  
(Robert Ennis, Retired Professor of Philosophy of Education at the University of Illinois)
- “The ability and disposition to improve one’s thinking by systematically subjecting it to intellectual self-assessment. (Richard Paul, Director of the Center for Critical Thinking and Moral Critique)
- “Any mental activity that helps formulate or solve a problem, make a decision, or fulfill a desire to understand. It is a searching for answers, a reaching for



meaning.” (Vincent Ruggiero, Professor Emeritus, State University of New York at Delhi, is recognized internationally as a pioneer in the movement to make the teaching of thinking a central emphasis in education)

- “Thinking that is purposeful, reasoned, and goal directed. It is the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions. (Diane Halpern, Psychologist at California State University)
- “Purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.” (The Delphi Report. Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. 1990)

### A CRITICAL THINKER Considers the Elements of Reasoning



**Paul and Elder describe eight Elements of Reasoning:**

1. All reasoning has a **Purpose**. In order to understand some proposition, one must be able to clearly define its Purpose (e.g. to persuade, inform, etc.).
2. All reasoning is an attempt to answer some **Question at Issue**—e.g. to figure something out, to settle some question, to solve some problem. It is important to identify that Question. In order to understand the Purpose.
3. All reasoning is based on **Assumptions**. Effective thinking seeks to clearly identify the writer’s assumptions and determine whether they are justifiable, and how they are shaping the author’s point of view.
4. All reasoning is done from some **Point of View**. Clear thinking seeks to identify the author’s Point of View.
5. All reasoning is based on **Information**—e.g. data and evidence. Clear thinking seeks to identify the writer’s information, and make sure that all information used is clear, accurate, and relevant to the question at issue. It also assesses whether or not the writer has gathered sufficient information.
6. All reasoning is expressed through, and shaped by, **Concepts and Ideas**. Therefore, it’s important to identify key concepts and explain them clearly. An example would be when discussing the topic of “love”, to understand what the writer means by “love”.
7. All reasoning contains **Inferences or Interpretations** by which we draw **Conclusions** and give meaning to data. It’s important to only infer what the evidence implies.

8. All reasoning leads somewhere, or has **Implications and Consequences**. It is important trace the implications and consequences that follow from one’s reasoning, searching for negative as well as positive implications, considering all possible consequences.

**Paul and Elder also describe nine Intellectual Standards used to assess the Elements of Reasoning:**

### Intellectual Standards Are Used to Assess Thinking

<b>Clarity</b>	Could you elaborate further? Could you give me an example? Could you illustrate what you mean?
<b>Accuracy</b>	How could we check on that? How could we find out if that is true? How could we verify or test that?
<b>Precision</b>	Could you be more specific? Could you give me more details? Could you be more exact?
<b>Relevance</b>	How does that relate to the problem? How does that bear on the question? How does that help us with the issue?
<b>Depth</b>	What factors make this a difficult problem? What are some of the complexities of this question? What are some of the difficulties we need to deal with?
<b>Breadth</b>	Do we need to look at this from another perspective? Do we need to consider another point of view? Do we need to look at this in other ways?
<b>Logic</b>	Does all this make sense together? Does your first paragraph fit in with your last? Does what you say follow from the evidence?
<b>Significance</b>	Is this the most important problem to consider? Is this the central idea to focus on? Which of these facts are most important?
<b>Fairness</b>	Do I have any vested interest in this issue? Am I sympathetically representing the viewpoints of others?

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1. **Clarity**. Is the Element being considered clear? For example, “Is the Purpose Clear? Or is it vague? Is the information Clear? Or is it ambiguous?” For instance, the Question “What is the best way to teach computer literacy?” is unclear. In order to

address the question adequately, one would need to have a clearer understanding of what the person asking the question is considering a “computer literate” person to be. A clearer question would be “What can educators do to ensure that students learn the computer skills and abilities which will help them function successfully on the job and in their courses?”

2. **Accuracy:** Is the Element (e.g. Information) really true? (A statement can be Clear but not Accurate, as in “Most computers have less than 1 MB of RAM”).
3. **Precise:** Is the Element Precise? (A statement can be both Clear and Accurate, but not Precise, as in “This computer has sufficient RAM.” We don't know how much RAM the computer has—it could be 50 MB or 4 GB.)
4. **Relevant:** Is the Element Relevant? A statement can be Clear, Accurate, and Precise, but not relevant to the question at issue. For example, some students believe that their grade should reflect the amount of effort they put into an assignment, though effort is usually irrelevant to the issue of whether or not an assignment is done properly.
5. **Depth:** Is the Element sufficiently deep, or is it superficial?
6. **Breadth:** Is the Element sufficiently broad, or do we need to consider a wider scope of data? (i.e. “Are the Conclusions mentioned in a report exhaustive, or are there other possible conclusions the author fails to mention?”)
7. **Logic:** Does the Element make sense? Is it sound? (i.e. Are the assumptions logical?)
8. **Significance:** Does the Element focus on the important, not trivial? Is this the most important problem to consider? Is this the central idea to focus on? Which of these facts are most important?

9. **Fairness:** Is the Element justifiable, not self-serving or one-sided? Do I have any vested interest in this issue? Am I sympathetically representing the viewpoints of others?

(Paul, R. and Elder, L. (October 2010). Foundation for Critical Thinking, online at website: [www.criticalthinking.org](http://www.criticalthinking.org))

### **Steps to Assess AND IMPROVE Your Own Thinking**

1. All reasoning has a PURPOSE.
  - Take time to state your purpose clearly.
  - Distinguish your purpose from related purposes
  - Check periodically to be sure you are still on target.
  - Choose significant and realistic purposes.
2. All reasoning is an attempt to FIGURE something out, to settle some QUESTION, solve some PROBLEM.
  - Take time to state the question at issue clearly and precisely.
  - Express the question in several ways to clarify its meaning and scope.
  - Break the question into sub-questions.
  - Identify if the question has one right answer, is a matter of mere opinion, or requires reasoning from more than one point of view.
3. All reasoning is based on ASSUMPTIONS.
  - Clearly identify your assumptions and determine whether they are justifiable.
  - Consider how your assumptions are shaping your point of view.
4. All reasoning is done from some POINT OF VIEW.

- Identify your point of view.
  - Seek other points of view and identify their strengths as well as weaknesses.
  - Strive to be fair-minded in evaluating all points of view.
5. All reasoning is based on DATA, INFORMATION, & EVIDENCE.
- Restrict your claims to those supported by the data you have.
  - Search for information that opposes your position as well as information that supports it.
  - Make sure that all information used is clear, accurate, and relevant to the question at issue.
  - Make sure you have gathered sufficient information.
6. All reasoning is expressed through, and shaped by, CONCEPTS and IDEAS.
- Identify key concepts and explain them clearly.
  - Consider alternative concepts or alternative definitions to concepts.
  - Make sure you are using concepts with care and precision.
7. All reasoning contains INFERENCES or INTERPRETATIONS by which we draw CONCLUSIONS and give meaning to data.
- Infer only what the evidence implies.
  - Check inferences for their consistency with each other.
  - Identify assumptions which lead you to your inferences.
8. All reasoning leads somewhere or has IMPLICATIONS and CONSEQUENCES.
- Trace the implications and consequences that follow from your reasoning.
  - Search for negative as well as positive implications.
  - Consider all possible consequences.

Elder, L. and Paul, R., (June 1996). Foundation for Critical Thinking, Online at website: [www.criticalthinking.org](http://www.criticalthinking.org))

### **Universal Intellectual Standards and Questions That Can Be Used to Apply Them**

Universal intellectual standards are standards which must be applied to thinking whenever one is interested in checking the quality of reasoning about a problem, issue, or situation. To think critically entails having command of these standards.

While there are a number of universal standards, the following are the most significant:

#### **Clarity:**

- Could you elaborate further on that point?
- Could you express that point in another way?
- Could you give me an illustration?
- Could you give me an example?

Clarity is a gateway standard. If a statement is unclear, we cannot determine whether it is accurate or relevant. In fact, we cannot tell anything about it because we don't yet know what it is saying.

#### **Accuracy:**

- Is that really true?
- How could we check that?
- How could we find out if that is true?

#### **Precision:**

- Could you give me more details?
- Could you be more specific?

**Relevance:**

- How is that connected to the question?
- How does that bear on the issue?

**Depth:**

- How does your answer address the complexities in the question?
- How are you taking into account the problems in the question?
- Is that dealing with the most significant factors?

A statement can be clear, accurate, precise, and relevant, but superficial (that is, lack depth). For example the statement “Just say No” which is often used to discourage children and teen from using drugs, is clear, accurate, precise, and relevant. Nevertheless, it lacks depth because it treats an extremely complex issue, the pervasive problem of drug use among young people, superficially. It fails to deal with the complexities of the issue.

**Breadth:**

- Do we need to consider another point of view?
- Is there another way to look at this question?
- What would this look like from a conservative standpoint?
- What would this look like from the point of view of . . . ?

**Logic:**

- Does this really make sense?
- Does that follow from what you said?
- How does that follow?

(Paul, R. and Elder, L. (October 2010). Foundation for Critical Thinking, online at website: [www.criticalthinking.org](http://www.criticalthinking.org))



**APPENDIX E**

**COURSE SYLLABUS FOR EXPERIMENTAL GROUP**

## ISYS 110 COURSE SYLLABUS

(Note: Highlighted items are those that are different than the control group syllabus)

Fall 2012

COURSE TITLE: Introduction to Computer Technology

CREDITS/CONTACTS: Credit Hours: 3

Lecture/Lab hours/weekly: 4

Weekly Contact Hours: 4

Final Exam Information: There is no final exam for this course, only three certification tests.

PREREQUISITE: Test score or a grade of C or higher in READ 100

### COURSE DESCRIPTION:

This course will provide you with an understanding of the basics of computing fundamentals, key applications, and living online. More specifically, this course covers computer hardware, operating systems, word processing, spreadsheets, presentation software, electronic mail, networks, and using the Internet, and the impact of computing and the Internet on society. The successful student will have satisfied the computer competency requirement of XXXXX College. This course includes certification.

### KEY CONCEPT OF COURSE

This course is designed to help you learn the logic and reasoning of computer literacy. Everything we do this semester will in some way, either broadly or narrowly, relate to improving your understanding of and thinking critically about computer literacy concepts and application of these concepts. The primary goal is for you to come to think as a

computer literate person would think. This includes identifying and working through problems which computer literacy individuals address.

#### GENERAL COURSE PLAN

This course is designed much differently from most others you have been exposed to because you will be asked to think critically about the subject matter throughout the semester. All of our activities will focus on helping you to better understand the reasoning of computer literacy, and to come to think like a computer literacy individual. You will be asked to continually engage your mind during class and while preparing for class.

The textbook will be used as a general resource for the course. You will learn to connect the reasoning of computer literacy to the logic of your own thinking so that the subject becomes relevant to you. While you will learn some "facts" about computers, they will be learned in the context of learning about the reasoning of computer literacy, rather than simply memorizing for the test.

You will be asked to bring some assignment to each class period, and each class period will build upon work done in the previous class period. Each student will actively participate in class sessions, as you are asked to continually process information by restating information, giving examples, offering alternate points of view, etc. You will also be involved in daily group work.

The ultimate goal is for you to learn to think critically about your thinking, so that you are able to accurately assess your strengths and weaknesses and to take charge of your thinking within the context of computer literacy.

## COURSE OUTCOMES:

The IC<sup>3</sup> training and certification program covers a broad range of computing knowledge and skills that demonstrates competency in the following areas: Computing Fundamentals, Key Applications, and Living Online. Certification requires participants to complete and pass all three course modules and related exams.

## COURSE OBJECTIVES:

### **Module A – Computing Fundamentals** students will learn to:

- Categorize computers on the basis of how they are constructed, how they are used or how they process data. Explain the I.P.O.S. data processing model. Identify the components of a personal computer and how these components function and interact.
- Categorize software as system (operating systems utilities and translators), applications (productivity, multimedia and home/personal). Select the best uses of each type of software.
- Perform the most frequently used functions of an operating system.

Upon completion of this course, the student will be able to:

- Identify types of computers, how they process information and how individual computers interact with other computing systems and devices.
- Identify the function of computer hardware components.
- Identify the factors that go into an individual or organizational decision on how to purchase computer equipment.
- Identify how to maintain computer equipment and solve common problems relating to computer hardware
- Identify how software and hardware work together to perform computing tasks and how software is developed and upgraded.
- Identify different types of software, general concepts relating to software categories, and the tasks to which each type of software is most suited or not suited.
- Identify what an operating system is and how it works.
- Solve common problems related to operating systems.
- Manipulate and control the Windows desktop, files and disks.
- Change system settings, install and remove software

**Module B – Key Applications** students will learn to:

- Perform functions common to all Windows applications with an emphasis on Microsoft Office applications Word, Excel and PowerPoint.
- Create, edit and format documents with a word processor.
- Create, edit and format worksheets with an electronic spreadsheet.
- Create, edit and format slides with presentation software.

Upon completion of this course, the student will be able to:

- Start and exit a Windows application
- Utilize sources of online help.
- Identify common on-screen elements of Windows applications
- Change application settings
- Manage files within an application.
- Perform common printing functions
- Edit or move text using cut, copy, paste, spell check and thesaurus.
- Format text, paragraphs and pages in word processing documents including automatic formatting tools.
- Be able to insert, edit and format tables in a word processing document
- Modify worksheet data and structure
- Format data in a worksheet.
- Sort data, manipulate data using formulas and functions
- Create and modify charts in a worksheet.
- Create and format simple presentations.

**Module C – Living Online** students will learn to:

- Use common terminology associated with computer networks and the Internet.
- Explain the benefits of networked computers, and the difference between different types of networks.
- Describe the use of electronic mail and other communications methods such as instant messaging.
- Use a Web browsing application and an Internet search engine.
- Identify the benefits and risks of computing and the role of the Internet in many areas of society, from home and work to school and recreation.

Upon completion of this course, the student will be able to:

- Identify the basic hardware components of networked computers
- Explain how protocols are used in networking and identify common protocols.
- Use current email software to create, reply to and forward electronic mail.

- Change e-mail software settings and automation features.
- Identify the appropriate use of e-mail and e-mail related "netiquette"
- Find Web sites and pages using a Web browser.
- Search the Internet using key word and Boolean search techniques.
- Identify how computers are used in different areas of work, school, and home
- Identify the risks of using computer hardware and software
- Identify how to use the Internet safely, legally, and responsibly

TEXTBOOK REQUIRED: Computer and Internet Essentials: Preparing for IC<sup>3</sup>,  
Rutkosky, Roggenkamp, Rutkosky, & Wempen,  
Lawrenceville Press, 2013

ADDITIONAL RESOURCES: USB Flash Storage Media

METHOD OF INSTRUCTION:

Students will be expected to read the textbook. Class discussion, questioning, lecture, group activities, and presentations will be used to augment the assigned readings. Students will be expected to read the assigned chapter(s) prior to the class the chapter(s) is/are assigned

EVALUATION METHOD:

Student will be evaluated on IC<sup>3</sup> exam, homework completion, practice test completion, group work, and class attendance and participation.

**A grade below C does not meet the core requirement for graduation.**

**Students earning a degree from the School of Business must attain IC3 certification.**

IC3 Exams (3)	684 pts
Homework	80 pts
CertiPrep Practice Tests	84 pts

Online Quizzes	80 pts
Class Attendance & Participation	72 pts
Total Points	1,000 pts

GRADING SCALE:	930 - 1,000	A
	900 - 929	A-
	870 - 899	B+
	830 - 869	B
	800 - 829	B-
	770 - 899	C+
	730 - 769	C
	700 - 729	C-
	670 - 699	D+
	630 - 669	D
600 - 629	D-	
Below 600	F	

**ATTENDANCE AND PARTICIPATION POLICY:**

Attendance and participation is extremely important to your success in this course. As a result, your attendance points will be determined not only by the number of classes that you attend, but also by whether you show up to class having done the preparation necessary to actively participate.

Outside class preparation will include reading assignments, online quizzes and assigned homework. In addition, for each class session, you will be required to write the answer to a question posed at the end of each class period. The question may result from the class discussion or may be prepared in advance by the instructor. These questions will be discussed at the beginning of each class period in small groups. Your written answers/papers will often be assessed by your peers. At the beginning of each class period, your work will be stamped. Students who have not written the assignment will not be allowed to participate in the

activity until they complete it. They will be asked to go to a designated table in the room to complete it.

Please note that in a hybrid course, if you miss more than 40% of the in person classes i.e. 3 in person classes, department policy states that you will automatically receive an F. While the instructor understands that some absences may be unavoidable, there is no distinction between an excused and an unexcused absence. It is the student's responsibility to notify the instructor when an absence will occur. Do not have another student tell the instructor that you will not be in class. Students are expected to make-up any missed assignments and they are responsible for all missed content.

#### EMAIL POLICY:

You are required to use your SMC Wired Email account to communicate with me. I cannot respond to emails other than SMC Wired. You should check your email regularly for class announcements from me. Sending an email is a good way to let me know that you are going to miss class or why you missed class and to find out what you missed because of your absence. Not having access to email, your email being down, or other email related excuses does not exempt you from contacting me. The phone is good second choice.

NOTE: When sending me an email, you **MUST** include the class section number followed by your name in the subject line. Example: 2137 Your Name

#### TESTING POLICY:

Certification Exams will be taken in class according to the schedule announced. Exams are timed (45 minutes) No notes, materials, etc. are allowed when taking the Certification Exam. Retake or make up exams will be available at the testing



center. Each student is allowed one retake at no extra cost. After that, there is a fee to retake an exam. Exam retake vouchers are available for purchase through the SMC business office.

- Prior to the first pre-test, you will need to register with Certiport®. This will take 20-30 minutes. The name you enter at registration will be the one used on your certification certificate.
- You are expected to test during the period specified, if you are unable to do so notify the instructor prior to the test period specified
- The testing center requires a picture ID. You must get there early enough to start testing an hour before the center closes. You must allow extra time for set up.
- You have one free retake for all three tests, not one for each test. After that, test retakes cost \$30 until the end of finals; When the semester is over, each retake costs \$50.
- If you need to retake a test, you must wait 24 hours after your last attempt.
- NO first attempts are permitted during final week. Retakes must be completed by the end of finals to receive a passing grade in the class.
- The instructor will not issue an “Incomplete Grade” due to work not being completed or exams not being taken or retaken in a timely manner. If you do not complete your assignments by the due dates and exams by the end of the semester, you will be assigned the grade that you have earned at that point.
- If you retake an exam or exams and obtain certification, or minimum score of 700, within 30 days of the end of the semester you have taken the class, you can ask your instructor for a change of grade.

NOTICE: Representative student work will be used as a part of SMC’s on-going curriculum assessment program.

#### OTHER COURSE EXPECTATIONS:

You are responsible for your own learning. Students are expected to participate in all group activities, attempt all assignments, and behave in a mature and professional manner. If you do not understand a topic or fall behind, then it is your responsibility to contact the instructor or seek tutoring.

#### HOMEWORK POLICY:

Homework completion is important to your success in this class as well as your overall grade. All homework is to be completed in Moodle or uploaded in the appropriate area of Moodle by midnight of the assigned due date. The time is based on SMC's server NOT the time on your computer. LATE ASSIGNMENTS WILL RECEIVE NO CREDIT. You will have one week from the time the homework is assigned to complete the assignment. It is recommended that you use your class time wisely to complete the assigned homework. All homework should be labeled with the following information and in this way. Name, CRN:, Date, Unit, Chapter Title of Questions i.e. Multiple Choice etc. For labeling a file you must have the above information on your document and label your file in the following format LAST NAME SECTION # UNIT #.Example LASTNAME 2137 UNIT 1. The instructor reserves the right to reject any homework not labeled appropriately.

FREE TUTORING: Free tutoring is available to all students through the Learning Center located in the college library. Contact the Learning Center for times and locations.

WITHDRAWAL: If you decide not to complete this course, you MUST officially withdraw before the withdraw deadline. Not attending class will not automatically withdraw you from the course. You will remain on the instructor's roster and receive a failing grade unless you meet with an advisor in Academic Support.

ACCEPTABLE USE OF PERSONAL COMMUNICATION TECHNOLOGY

**All electronic communications devices must be turned off during class.** If you

are expecting an urgent call, you must pre-approve with the instructor and are required to leave the classroom before answering if approved. This policy includes any and all Internet communications. Obviously, the exception would include class related exercises. First violation of this policy will result in a warning and no credit for attendance for that class period. Second violation will result in your removal from the classroom for the class period and you will not have been considered present. Multiple violations of this policy will be referred to the appropriate dean for disciplinary action. Further details or ramifications of violations maybe found elsewhere in this syllabus. The instructor has the right to modify this policy to meet the needs of your course.

#### HONESTY POLICY

Cheating or plagiarizing will absolutely not be tolerated at XXXXX College. Any student found cheating or plagiarizing material in any manner will be assigned a failing semester/session grade in this course. A second such incident while at SMC could result in suspension or expulsion from the institution. A student found in violation of this section of the syllabus will not be allowed to drop this course. Additional detail regarding cheating and/or plagiarism may be found elsewhere in this syllabus. For more detailed information consult the SMC Student Code of Conduct.

#### PROFESSIONALISM POLICY :

Students will be asked to present themselves in a positive and professional manner inside the classroom. The entire department will be requiring this of students in

order to begin to prepare them for the workplace. Students should think of their classes like a job and instructors as their employers.

- **TARDY** - Students will not be allowed in class after the start of class. It will be up to the instructors to allow them into class at a break.
- **ATTIRE** – Students should refrain from wearing revealing or tight clothing, hats, or other attire that would not be allowed in a normal professional business setting.
- **CELL PHONES & PAGERS** – All cell phones should be turned off or put on manner mode before entering the classroom. Absolutely no calls should be taken during class time.
- **VOCABULARY** – Students should refrain from swearing or using unprofessional language in the classroom. Also, a professional vocabulary should be adopted and used in class as they progress in their college careers.
- **WEAPONS** – No weapons should be brought to class.
- **OVERALL PROFESSIONALISM** – Students should begin to adapt an overall professional demeanor and attitude.

#### CLASSROOM BEHAVIOR:

Students are expected to assist in maintaining a classroom environment that is conducive to learning. In order to assure that all students have the opportunity to gain from time spent in class; students are prohibited from engaging in any form of distraction. Inappropriate behavior in the classroom shall result, minimally, in a request to leave class.

#### DIVERSITY STATEMENT:

It is the goal of the School of Business to embrace diversity, to recognize differences in race, ethnicity, gender, gender identity, sexual orientation, age, social class, physical ability or attributes, religious or ethical values system, national origin, and political beliefs. The School of Business will create and sustain an environment that welcomes diverse populations. We will create a

learning environment for students that truly enrich and enhance them personally and professionally by incorporating an understanding of and enhancing knowledge of diverse populations as part of our curriculum.

NOTICE: Information in this syllabus was, to the best knowledge of the instructor, considered correct and complete when distributed for use at the beginning of the semester. The instructor, however, reserves the right, acting within the policies and procedures of XXXXX College, to make changes in course content or instructional techniques.

**NO FOOD OR DRINKS ARE ALLOWED IN ANY SMC COMPUTER LAB AT ANY TIME.**

Wk	Date	Topic	Chap
		Syllabus, ground rules, and what to expect, COMPUTING FUNDAMENTALS Lab - Pre-test	
1		Topic 1: Understanding and Selecting a Computer	1
		Topic 2: Using an Operating System	2
2		Topic 3: Choosing and Using Application Software	3
		Exam Review	
3		CERTIFICATION EXAM – COMPUTING FUNDAMENTALS, KEY APPLICATIONS Pre-test	
		Topic 4: Working with Microsoft Office 2010 Applications	4
4		Topic 5: Editing a Document in Word	5
		Topic 6: Formatting Characters and Paragraphs in Word	6
5			
		Topic 7: Creating and Enhancing Tables in Word	7
6		Topic 8: Formatting a Document in Word with Special Features	8
		Word Exercises and Review, Topic 9: Analyzing Data Using Excel	9
7		Topic 10: Formatting an Excel Workbook	10
		Topic 11 : Preparing a Presentation	11
8		Topic 12: Inserting Graphic Elements in a Presentation and Integrating Word, Excel, and PowerPoint	12
		Word, Excel and PowerPoint Exercises and Review	
9		CERTIFICATION EXAM Key Applications	
		LIVING ON LINE Pre-test, Topic 13: Understanding Networks and the Internet	13
10		Topic 14: Using a Web Browser	14
11		Topic 15: Using Email	15

	Topic 16: Using PCs and the Internet Safely and Responsibly	16
12	Exam Review	
	CERTIFICATION EXAM Living Online	
13		
	Final Exams - Exam Retakes if Necessary	
14		

**APPENDIX F**

**STUDENT CRITICAL THINKING ASSIGNMENTS**

# ISYS 110 Student Critical Thinking Assignments

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The following taken from (Rutkosky, Roggenkamp, Rutkosky, & Wempen, 2013)

## **Topic 1: Selecting a Device**

Suppose an elderly relative, who has never owned a computer before, is interested in buying a device that will enable her to read online magazines and get email. She has poor vision, and has difficulty using devices that have buttons. She is not interested in running complex games or applications, and would like something that she could move between rooms of her house without asking anyone for help. Evaluate your relative's situation and write a half to one-page paper recommending the type of computing device that is best suited for the situation. In your paper, explain why you chose that device and why the other types of devices you learned about in this chapter would not be a good fit (p. 56).

## **Topic 2: Troubleshooting Common Computer Problems**

List what actions you would take to resolve each of the following problems:

- a.) System performance is suddenly sluggish.
- b.) An application crashes (or it does not respond).
- c.) Windows crashes when starting up.
- d.) You cannot find a certain file or folder.
- e.) An error message reports the hard drive is becoming full.
- f.) A file cannot be opened, shared or modified.
- g.) A file is damaged or corrupted.
- h.) No application is available to open data files of a certain type.

## **Topic 3: Producing an Electronic Game**

Imagine you have designed an electronic game that you want to produce and sell to the public. Consider how you will manage this process. Will you try to do everything yourself so you can keep all the profits from your game, or will you hire others to help you with certain parts of the work? For example, will you:

- Program the game yourself or hire a programmer?
- Duplicate the discs yourself or use an outside vendor?
- Design the product packaging yourself or hire a designer?
- Contract with a large company to distribute your game or sell it on your own website?

Write a response stating your management choices. Support your choices with logical reasoning (p 169).



**Topic 4: Researching System Requirements and Identifying Helpful Applications**

You are a recent hire at a bookstore. Your boss, Mary Harrison, is considering updating her work computer to Microsoft Office 2010. She has asked you to use the Internet to go to the Microsoft home page at [www.microsoft.com](http://www.microsoft.com) and then use the search feature to find information on the system requirements for Office Professional Plus 2010. When you find the information, type a document in Microsoft Word that contains the Office Professional Plus 2010 system requirements for the computer and processor, memory, hard disk space, and operating system.

Mary Harrison has also asked you to determine what type of files you could create with Word, Excel, and PowerPoint to help her manage and promote the bookstore. Open Word and create a document listing two to three types of files you can create for each application (p. 211).

**Topic 5: Locating Information and Writing a Memo**

Using the Internet, locate information on three colleges in your state. Research a specific degree program that interests you at each college. At a blank document, write a memo to your instructor describing each college, the specific degree program you researched at that college, and any other information you feel is pertinent about the schools. Save the completed memo and name it U2T5-CollegeMemo. Print and turn in to your instructor (p. 251).

**Topic 6: Identifying and Applying Appropriate Fonts**

You work for the student newspaper, and the editor, Leah Gardner, would like you to maintain consistency in articles submitted for the monthly newspaper. She wants you to explore various decorative and plain fonts. She would like you to choose two handwriting fonts, two decorative fonts, and two plain fonts, and then prepare a document containing an illustration of each of these fonts. Save the document and name it U2T6-C01-Fonts. Print and turn in to your instructor (p. 298).

**Topic 7: Creating an Employment Application Form**

You work for Summit Fitness Center and have been asked by your supervisor to create an employment application form that a person fills out when applying for a job with the center. Create a form using a table that minimally includes the following information along with space for the applicant to handwrite the information: name, address, telephone number, cell phone number, experience, references, education, and any other information you determine is necessary for an employment application form. Save the completed form and name it U2T7-C01-AppForm. Print and turn in to your instructor (p. 332).

**Topic 8: Creating an Announcement**

1. At a blank document, create an announcement for Career Finders by typing the text shown in Figure 8.1 below.
2. Change the font for the entire document to a decorative font, size, and color of your choosing
3. Insert, size, and move a clip art image of your choosing in the document. Chose a clip art image related to the subject of the announcement.
4. Save the document and name it U2T8-A2-CFAnnounce.
5. Print and turn in to your instructor (p. 386).

CAREER FINDERS

Career Exploration

February 8, 1:30 to 4:30 p.m.

Resume Writing

February 9, 9:30 to 11:30 a.m.

Interview Skills

February 10, 2:00 to 5:00 p.m.

Contact Kyle Silvers for additional workshop information.

**Topic 9: Understanding**  
 Imagine that you are a  
 Microsoft Excel. To  
 understand common  
 problems and an in  
 provided, determine  
 or as directed by your instructor (p. 151).

ent in  
 t you  
 set of  
 nation  
 s provided

	A	B	C	D
1	5	15	10	
2				

**Figure 9.1**

1. \_\_\_\_\_ =SUM(A1:C1)
2. \_\_\_\_\_ =AVERAGE (A1:C1)
3. \_\_\_\_\_ =MAX(A1:C1)
4. \_\_\_\_\_ =MIN(A1:C1)
5. \_\_\_\_\_ =COUNT(A1:C1)
6. \_\_\_\_\_ =B1+(A1\*C1)
7. \_\_\_\_\_ =C1\*(B1-A1)
8. \_\_\_\_\_ =C1/(B1-A1)
9. \_\_\_\_\_ =A1+C1-B1
10. \_\_\_\_\_ =B1+C1\*A1

**Topic 10: Selecting the Most Appropriate Chart**

Read the following three scenarios and identify what type of chart (bar, column, pie, or scatter chart) would best accomplish the desired effect. Write a sentence explaining which chart you would use for each scenario and why (p. 478).

1. The VP of Accounting has asked for a chart that will portray the company's different expense categories in percentages.

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2. The VP of Accounting has asked for a chart that will portray the company's expense categories in relation to the total amount of expenses for each of the last five years.

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3. A researcher has asked for a chart that will portray the relationship between an individual's IQ and age using a sample of 100 people of all different ages.

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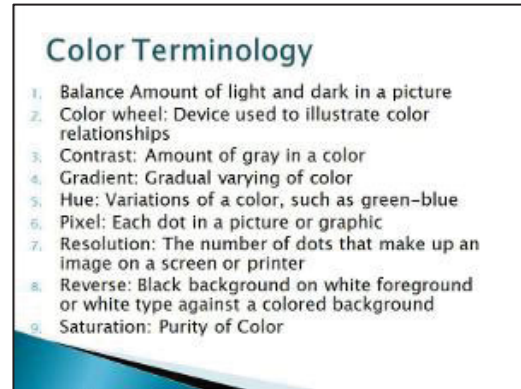
**Topic 11: Suggesting Improvements to Slide Design**

Look at each slide below and then determine at least two things you would do to improve the slide. Use the information in the Delving Deeper section in this topic as a reference for deciding what you would change in each slide. Create a Word document and type a list of the changes you would make to each slide. Save the completed Word document and name it U2T11-CT-Slides and submit it to your instructor (p. 524).

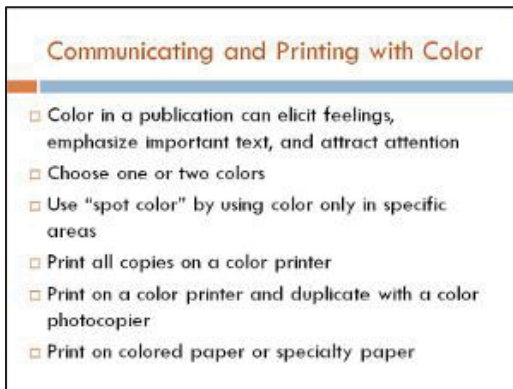
Slide 1



Slide 2



Slide 3



## Topic 12: Researching and Creating a Presentation on the Use of Color in a Presentation

Research on the Internet guidelines for using color in a PowerPoint presentation. Find at least three suggestions for using color in a presentation (such as color combination suggestions, color combinations to avoid, the purpose of color, color backgrounds, and so on) and then create a presentation with a title and a slide for each suggestion. Apply formatting and color to enhance the visual appeal of the presentation and make sure the text on each slide is easy to read. Save the presentation and name it U2T12-Color and submit it to your instructor (p. 578).

## Topic 13: Analyzing Communication Methods

Topic 13 discusses numerous communication methods used in today's society. Imagine that you have been asked to explain proper communication methods to a group of young students. In preparation, you decide to come up with three scenarios to describe these methods. In a Word document, type your answers to the following questions:

1. Describe a situation where sending a letter through postal mail would be the most appropriate way to communicate. Explain why email and text messaging would not be as acceptable.
2. Describe a situation where sending an email would be the most appropriate way to communicate. Explain why postal mail and text messaging would not be the best options.
3. Describe a situation where sending a text message or IM would be the most appropriate way to communicate. Explain why postal mail and email would not be the best option. Save the document as U3T13-CT-Comm and submit to your instructor.

#### **Topic 14: Making IT Decisions**

Imagine that you are the IT manager of a local business. Do you believe that everyone in your company should be using the same web browsing software? What would be the advantages of requiring everyone to use a single browser, and what would be the disadvantages? Explain your position in a Microsoft Word document and support your views with logical reasoning. Save the document as U3T14-CT-Browser and submit to your instructor.

#### **Topic 15: Transferring Large Files Online**

Some email applications and mail servers limit the size of the attachments you can send and receive to avoid using too much bandwidth and slowing down serve for other users. If you have a large file to send, or a series of large files, you might consider finding another way of delivering them to the recipient.

Analyze the following questions and use your prior knowledge and computer literacy to determine the answers. Record your views in a Notepad, Word, or WordPad document and save the file as U3T15-CT-Attachments.

1. Why might it be considered rude to send large email attachments?
2. What other ways could you transfer files to someone over the Internet?
3. If the Internet were not available, what ways could you transfer large files to someone?

Save the completed file and send it to your instructor as an email attachment. Type **Topic 15 Critical Thinking** in the *Subject* text box of the email message.

## **Topic 16: Warning Others of Online Dangers**

1. Open PowerPoint
2. Based on your experience and what you learned in this topic, create an informative presentation on what you consider to be the most dangerous threats to inexperienced computer users. Use the skills you learned in earlier topics to create a dynamic and visually appealing presentation. Use one slide for each type of threat, making sure to describe the danger and how it can be avoided.
3. Save the presentation as U316-A7-Threats and submit to your instructor.

**APPENDIX G**  
**IRB APPROVAL LETTER**

Connie Meinholdt, Ph.D. - Chair  
820 Campus Drive  
Ferris State University  
Big Rapids, MI 49307  
(231) 591-2759  
IRB@ferris.edu

To: Dr. Elizabeth Stolarek & Joseph Vitanza

From: C. Meinholdt, IRB Chair

Re: IRB Applications #120705 (Title: The Role of Critical Thinking Skills in the Teaching of Computer Literacy in the Community College)

Date: December 4<sup>th</sup>, 2012

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, “The Role of Critical Thinking Skills in the Teaching of Computer Literacy in the Community College” (#120705) and approved it as *expedited – 2G*. This approval has an expiration date of one year from the date of this letter. As such, you may collect data according to procedures in your application until December 4<sup>th</sup>, 2013. It is your obligation to inform the IRB of any changes in your research protocol that would substantially alter the methods and procedures reviewed and approved by the IRB in this application. Your application has been assigned a project number (#120705) which you should refer to in future applications involving the same research procedure.

The full committee met to discuss your statement that participation in this research is not voluntary. Although the committee approved a consent waiver for your study, we wish to emphasize your responsibility to protect participant rights, especially as defined in the Family Educational Rights and Privacy Act and the code of federal regulations governing the conduct of human subjects research.

We also wish to inform researchers that the IRB requires follow-up reports for all research protocols as mandated by the CFR (Code of Federal Regulations) 45, Title 46 for using human subjects in research. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor. Please let me know if I can be of future assistance.