THE RELATIONSHIP BETWEEN INSTRUCTIONAL TECHNOLOGIES AND KNOWLEDGE ACQUISITION IN A COLLEGE SETTING

by

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CHAPTER 1: INTRODUCTION

Technology is often beneficial in business for increasing productivity (Daniels, 2005; Kamal & Petree, 2006; Parry, 2005; Robins, 2006) and for keeping business competitive. Over a twenty-year period, many contemporary organizational and educational leaders have pursued technology as the solution for controlling and reducing organizational costs through increased efficiency. Productivity affects all organizations, whether these entities are for-profit or nonprofit, large or small, manufacturing or service. At each of these settings, technology may increase productivity but deriving the full benefits of this investment is contingent upon identifying, measuring, and collecting the magnitude of each benefit, and implementing a follow-up plan that uses the data collected.

Organizational leaders of educational institutions may suffer from the same dilemma (Little, 2008). Many people judge educational institutions by the efficiency with which faculty members transfer knowledge to students, and the pace at which students acquire knowledge. Similarly, business executives evaluate training programs to identify the effectiveness with which the training program is able to transfer new skills and abilities to organizational trainees (Redford, 2006; Westhead, 2005). If education and training programs are not effective, as shown by the results of longitudinal studies, there is little justification to continue using the same methods. What will take place in the proposed quantitative correlational study will be to determine the relationship of visual, verbal, or kinesthetic instructional technology to the acquisition of knowledge. Study results may be useful in measuring the benefits to learning stemming from future investment in Web-based and whiteboard instructional technologies.
Chapter 1 serves as a general framework for the study by describing the background and statement of the problem, the purpose of the study, and the significance of the problem. Chapter 1 further covers the nature of the study, the research question and hypotheses, and the theoretical framework. Also, found in chapter 1 are the definitions of terms, assumptions, limitations, delimitations, and the summary.

Background of the Problem

Scholars from many civilizations have debated and researched for centuries how humans learn. In that debate and search for the truth, people invested incalculable human capital over the millennia. Socrates and Meno concluded that a man has unexplained knowledge; therefore, the “soul must have always possessed this knowledge” (Jowett, 1875, p. 289). Jowett’s translation of *The Dialogues of Plato* revealed in Phaedo that Socrates believed “those who are said to learn only recollect, and learning is simply recollection” (p. 451). From the writing of Plato, the inference is that humans may be born innately with all the knowledge they will possess. In a critical thinking process the perception is that, some connection occurs that triggers a recollection and creates an awareness of prior knowledge. As philosophers continued to debate, John Locke identified a different paradigm for attaining knowledge (Mathewson, 2006).

Locke (1838) asserted in his 17th century writing that perception is a part of the process for exposing the knowledge humans possess. Knowledge as a domain resided in the “learned man” (Leites, 1978, p. 38), who gained his knowledge from the processes by which he learned and retained information other than intuitive knowledge. Knowledge, according to Locke, consisted of two types, “intuition and demonstration” (p. 396). Classification and acquisition of intuitive knowledge may be of importance. Locke asserted that knowledge other than intuitive knowledge is composed of “such truths
whereof the mind having been convinced, it retains the memory of the conviction” (p. 390).

Through demonstration, the individual engages the mind to accept truths as evidence of proof. As complexity of knowledge increases, even demonstration or exhibition of the desired knowledge is not enough to ensure that people will retain the knowledge. Understanding of the acquisition of knowledge has progressed considerably since that time.

Learning styles are tendencies humans use in the learning process to acquire knowledge and recall that knowledge for awareness, thinking, recollection, and decision-making ability (Evans, 2008). Learning styles should influence how instructors, facilitators, trainers, or technology delivers information for consumption. Traditional pedagogy models instructions or information in text format on a chalkboard accompanied by some verbal explanation. Chalkboard or visual pedagogy are sufficient for some students but may cause problems for students who have a different learning style. Research suggest that the learning style of the instructor becomes the foundation for the instructor’s pedagogical preferences and that consideration for the students’ learning preferences is important when trying to influence how students learn (Hunt, Meyer, & Lippert, 2006). A problem for knowledge acquisition by students occurs when instructors’ preferred pedagogy and students’ learning styles are mismatched. In the last decade, Sweller (Clarke, Ayres, & Sweller, 2005; Gog, Ericsson, Rikers, & Paas, 2005; Scandura, 2007; Schär & Zimmermann, 2007) has provoked increased awareness of additional limitations for knowledge acquisition.

Cognitive load theory focuses on the limitations of the working memory. Sweller and Chandler (1994) categorized the limitations of working memory as extraneous and
intrinsic cognitions that differ in the factors that influence human cognitive load. Intrinsic
cognitive load depends on the fundamental structure of the information, which is
essentially fixed. Extraneous cognitive load, the ability of humans to retain memory for
recall, is a function of “instructional designs” (Sweller & Chandler, p. 226).

Cognition is a function of applied knowledge as an observation of engagement
among peers, which occurred when participants crossed cultural boundaries as in a study
Cumming-Potvin et al. noted that to solve problems, students “appropriated and applied
knowledge in formal and informal contexts and from one language to another” (p. 66).
The 28 fourth year students in Cumming-Potvin et al. formed attitudes regarding the
effectiveness of various pedagogical practices through years of experiences and attending
courses. Through the classroom experiences stored in learner’s memory, learners may
create the expected foundation for delivery of course curriculum. Traditional classroom
instruction of lecturing to students is still a common component (Durham, McKinnon, &
Schulman, 2007; Hashemzadeh & Wilson, 2007) in the college macro and micro
economic curriculum.

Lecturing to students is a tradition that college students expect (F. Wei, 2007). For
students to learn instructional objectives the structure of lecture pedagogy can be
inefficient. Instructors who lecture to students for long periods using visual (chalkboard)
and auditory (lecture) communication channels overload the ability of all students
passively to absorb the content. The amount of information processed simultaneously
through multiple senses, such as auditory and visual; create a limitation on the working
memory. Another limitation of information processed simultaneously is that while the
student’s mind is processing the current information by synthesizing, comparing, and
cataloging it with prior knowledge, the instructor often is discussing new information, thus creating an overload situation. Instructors recognize that something is wrong when students begin to lose attention and cannot answer content-associated questions. Students’ preferences extend beyond the internal capacity of the mind to process information to include their preferences for a combination of learning styles.

Felder and Silverman (1988) defined the four learning styles of active, inductive, sensing, and sequential patterns related to knowledge acquisition. R. Dunn, K. Dunn, and Price (1986) found other learning styles and classified learners into visual, auditory, or kinesthetic learners. With an increasing variety of learning styles present in the individual, an important consideration in the attempt to facilitate knowledge acquisition is first to determine the composition of the individual’s learning style in order to frame the delivery of the knowledge (Richardson, 2005). Researchers persist in the investigation of ways that the brain learns. At the same time, the revelation that there still is much that is unknown about how people learn continues to challenge instructors.

In the last 2 decades, a desire to use technology to facilitate the acquisition of knowledge has surfaced. Instructional technology is a major investment. The U.S. Department of Education (2006) reported that it appropriated $496 million in 2005 and for the past 5 years, channeled over $3 billion (p. 1). Educators, government officials, and business organizational and educational leaders believe that instructional technology has a positive influence on learning (Renzulli, & Reis, 2007, p. 63). A lack of a clear understanding regarding how much the technology truly is helping individuals with the acquisition of knowledge is a problem. If these investments in instructional technologies fail to be beneficial, then organizational leaders can divert the investments to activities
that have a more direct bearing on knowledge acquisition, such as professional
development, teacher conferences, and smaller classes.

Statement of the Problem

Hashemzadeh and Wilson (2007) stated that research has not adequately
determined and documented what benefits exist from using instructional technology. This
public investment transpires each year without research to show that using technology
leads to improved learning. To date, government and educational officials assumed the
investment has to be beneficial without much attention or interest in determining whether
the presence of technology augments student achievement. Investment for instructional
technologies for K-12 schools grew from “$2 billion in 1991-1992 to nearly $6 billion in
2003-2004” (Peslak, 2005, p. 111) with no evidence that instructional technologies
improve performance. Yet, the U. S. government and schools spend tremendous sums of
money for instructional technologies without requiring documented evidence of the
benefits. Domestic educational institutions committed more than $5.7 billion or 7.3% of
the total education budget in the United States during the 2003 fiscal year for classroom
instructional enhancements (McIntire, 2004, p. 32).

The specific problem is that to date research has not adequately documented the
benefits of using instructional technologies with verbal, visual, and kinesthetic activities.
Without understanding if instructional technologies have a relationship to knowledge
acquisition, organizational leaders are unable to calculate a return on investment.
Improving the competitive disadvantage that faces America today, means that
organizational leaders need a better understanding or the benefits related to the
investment in instructional technologies. The finding of this study may provide evidence
on whether the benefits of instructional technology are providing an acceptable rate of
return on the investment. If these findings indicate that the costs involved exceed the benefits received then perhaps an effective alternative investment to stimulate levels of knowledge acquisition would be the appropriate choice for organizational leaders.

National authorities recognize that America’s competitive disadvantage is a very urgent problem. This urgency was summarized in 2005, The National Center for Public Policy and Higher Education identified that “as other developed nations continue to improve the education of their workforces, the United States and its workers will increasingly find themselves at a competitive disadvantage” (p. 1).

Callan, Ewell, Finney, and Jones (2007) cited that the “National Center for Academic Transformation has demonstrated that learning outcomes can be improved and costs reduced by reengineering courses to incorporate technology and change the ways expensive human resources are utilized in the instructional process” (p.17). Examination of the relationship between the use of visual, verbal, or kinesthetic instructional technologies and knowledge acquisition is the purpose of this proposed quantitative correlational study. The proposed study will investigate the relationship between the use of visual, verbal, or kinesthetic instructional technologies and acquisition of knowledge in a community college sophomore-level business course.

Instructors in higher education often work with learning outcomes that frame the content for the course. To assist students in acquiring new knowledge to meet course outcome, instructors use a set of instructional techniques (Rodrigues, 2005) that includes the use of instructional technologies. Expenditures for instructional technologies include classroom interactive whiteboards (Clyde, 2004), on-line applications, programmed learning (Ansalone & Ming, 2006), video, video- and text-based learning objects
Purpose of the Study

The purpose of the proposed quantitative correlational study is to examine the relationship between student’s use of visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and the acquisition of knowledge, as evidenced by scores on the Test of Understanding in College Economics (TUCE). By adding curricular enhancements produced by the whiteboard and Web-based instructional technologies to include an audio explanation of course content, text-based documents, and hands-on activities, what will take place is the determination of the relationship between the use the curricular enhancements and knowledge acquisition. For the proposed study, the dependent variable will be the students’ incremental level of new economic knowledge acquired.

The instrument used in the proposed study is the TUCE. For the proposed study, the independent variables will be age, gender, minority status, educational major, technological experience, and the use of the whiteboard and Web-based technologies for visual, verbal, or kinesthetic activities. Students enrolled in economics courses at a community college in Arizona will represent the study population of 130 college students.

Significance of the Study

Organizational leaders frequently make decisions on the allocation of scarce resources. Return on investment too often determines if the allocation of scarce resources meets the organization’s threshold for investment. Businesses and educational institutions spend billions of dollars annually on technology to facilitate the acquisition of
knowledge. Investment in instructional technology for advancing the acquisition of knowledge is a costly expenditure with unknown efficaciousness. It remains clear that the tremendous investment in instructional technologies in recent decades has not lead to improvements in student achievement levels. Evidence of this fact is found in reports from national standardized testing organizations that students have relatively flat or declining scores on the National Assessment of Educational Progress (NAEP) (Kerachsky, 2009), American College Testing (ACT) (ACT, 2009), Scholastic Assessment Test (SAT) (College Board, 2007), and the Graduate Record Examination (GRE) (Grandy, 1999).

The National Assessment of Educational Progress assessed students enrolled in math and reported that the “less than one-quarter of 12th-graders perform at the proficient level or higher” (Grigg, Donahue, & Dion, 2007, p. 15). The American College Testing report for comparing high school test scores for 1998 – 2008 showed no statistically significant change in the composite scores (ACT, 2009). For the Scholastic Assessment Test report for college bound seniors reported that from 1997- 2007 scores for critical reading declined whereas, scores for mathematics increased (College Board, 2007). The Graduate Record Examination report on GRE test scores stated that “for all broad areas of study, GRE verbal score averages rose between 1982 – 1989 or 1990, after which they began a steady decline” (Grandy, 1999, p. 37).

Various researchers suggested that there might be some benefit regarding the ability of technology to improve the acquisition of knowledge (Lévesque, 2006; Paquin, 2002; Turmo, Ageno, & Catalá, 2006). Clarke et al. (2005) found that instructional technology might benefit knowledge acquisition by reducing the limitations imposed by “cognitive load” (p. 22). Stahl, Finke, and Zahn (2006) further suggest that technology
improves the acquisition of knowledge. Yet, to date, research had not provided sufficient positive findings to aid organizational and educational leaders and decision makers in making sound instructional technology investments.

The proposed study is unique in that knowledge recall will be examined by the specific learning style of the student using instructional technologies. Cognitive processes are a key in developing and using instructional technology so that there is a chance to guarantee a positive outcome for improving learning. Executive leadership may find the study results useful when investing in instructional technology directly aimed at improving institutional teaching and learning. Ensuring a positive return on investment becomes increasingly important to organizational and educational leaders, who commit to purchasing instructional technology, who soon afterwards face further commitments to acquiring new versions of software and upgrades in order to keep their expensive technologies functional. Study results may help fill the void of information regarding the potential benefits that may stem from instructional technology choices and improvement to institutional teaching and learning.

Decision makers in organizational and educational leadership need valid research about instructional technologies’ effect on the acquisition of knowledge to facilitate the ability to make confident decisions on investments that either facilitate learning or meet the expectations of learners for technologically enhanced teaching. For the proposed study, the significance for organizational and educational leaders may be the ability to make decisions on the investment and implementation of instructional technologies based upon the institutions’ rate of return on productivity and weighing costs to benefits gained.
Nature of the Study

For the proposed quantitative correlational study, the nature of the study is to determine the relationship of utilizing the instructional technology of Tegrity, which consists of a whiteboard instructional technology, audio recording software, and a Web-based instructional technology and acquisition of knowledge. Research methods available to examine the utility of Tegrity include quantitative, qualitative, and mixed methods. The quantitative method “asks specific, narrow questions, collects numeric (numbered) data from participants, analyzes these numbers using statistics, and conducts the inquiry in an unbiased, objective manner” (Creswell, 2005, p.39). The primary data to be used in the analysis are test scores, a quantitative data element. The test score data element is associated with other independent variable for age, gender, minority status, educational major status as business or non-business, technological experience that are also quantifiable. Thus, the qualitative aspect this being a stand alone, or mixed methods study, does not provide additional insight into a study that is intrinsically data driven.

Nor does the study focus on increased learning levels as measured by pre and post-test scores, which can be as readily associated with factors influencing the learning that has transpired as quantitative research. Furthermore, past research on the subject has also been quantitative in approach. Similar studies with pre and post-test instruments have utilized the quantitative method (Schär & Zimmermann, 2007, Schmidt, 2007). For the proposed study, investigating knowledge recall “depends on the relationship” (Park, Giroud, Mirza, & Whitelock, 2008, p. 18) between the factors involved.

The qualitative method has information that “relies on the views of participants, asks broad, general questions, [and] collects data consisting largely of words (or text) from participants” (Creswell, p.39). The mixed method combines a quantitative method
and a qualitative method that potentially describes the causal relationship of what is occurring. Additionally, researchers may use the mixed method to determine why the relationship is occurring (Howard & Borland, 2007). Since increases in the learning levels are not directly attributable to association with these gains through a “collection of words and thoughts of other people” (Trosset, 2007, p. 9) it is not appropriate in this case to use a qualitative or mixed method.

For the proposed study, students’ knowledge recall of economic concepts, demographics of the research participants, and the activity rates with the instructional technologies will be measured. The data set for the study is a collection of numerical and categorical items representing the dependent and independent variables. Tegrity is one of the early developers of instructional technologies. Tegrity consists of an easy to use point-and-touch mapping of the traditional classroom whiteboard and continues to provide advanced technological enhancements.

In this adaptive teaching and learning environment, Tegrity is suited well to correlation measures how one or more independent variables covary where “creativity is strongly linked with story writing ability” (Riley & Åhlberg, 2004, p. 252) the dependent variable. Instructors use Tegrity to aid them in developing and delivering content for various pedagogical environments. Organizational members of educational institutions use instructional technologies like Tegrity to adapt, modify, and deliver curriculum, projects, and presentations, thus providing learners with alternative multimedia formats from which to acquire knowledge.

The Tegrity system is also well suited to provide content for knowledge acquisition to students with differing learning styles. With the ability to include hyperlinks into the presentation, students and instructors can use real time information
available from the Web and embed that information into the presentation. Students can click on hyperlinks that connect them to learning objects that give students hands-on practice to develop a greater understanding of difficult concepts. Learning objects are small focused pieces of curriculum that students can access to assist in the learning process. Learning objects have an advantage over static activities in that immediate feedback is provided to students concerning personal success in understanding content (Busetti, Dettori, Forcheri, & Lerardi, 2007; Nugent, Soh, & Samal, 2006). Students may progress further and attempt mastery of other sets of knowledge by using the feedback provided.

Students with different learning styles can become more active in engaging a preferred learning style to acquire new knowledge with each of the visual, verbal, or kinesthetic activities as inclusions. Learners can utilize innate learning styles associated with the verbal learner through the audio enhancements and, to compliment their learning style of kinesthetic learners, can include hands on activities.

For the proposed study, data provided from the subset of the population of student scores for the nationally recognized pre- and post-economics test (i.e., the TUCE) and associated data on student engagement with the instructional technology will be used. The data set will include students’ use of the course’s economic content. TUCE is a widely used assessment measure that instructors of economic education employ (Dickie, 2006; Emerson & Taylor, 2004; W. B. Walstad & Watts, 2005). For the proposed quantitative correlational study, the design will aid in determining the ability of instructional technologies to improve the acquisition of knowledge. Past research studies focused on the acquisition of knowledge and technology in terms of new learning
processes (Assimakopoulos & Yan, 2006; Campdesuñer, 2007; Falvo & Solloway, 2004; Guri-Rosenblit, 2005; R. Muro & E. Muro, 2004).

The t-tests, regression, quasi-experimental, and non-parametric tests were the other statistic methods considered. Researchers use the t-test to “determine the statistical significance between a sample distribution mean and a parameter” (Cooper & Schindler, 2008, p. 483). The proposed study will include scores on student’s pre- and posttest scores. The t-test would be inappropriate because the observations are not independent.

Regression analysis is used to determine the predictably how changes in one variable effect another variable. The design of the proposed study is focused on determining if there is a relationship between student’s use of visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and the acquisition of knowledge, as evidenced by scores on the Test of Understanding in College Economics (TUCE). Since regression analysis is designed to “further our insight into the relationship of Y with X” (Cooper & Schindler, 2008, p. 538), which is beyond the scope of this study; it is inappropriate to use regression analysis.

Quasi-experimental analysis incorporates data where the “investigator does not randomly assign participants to groups” (Creswell, 2005, p. 298). The proposed study will use a random assignment of students to a control group. Researchers often use the quasi-experimental analysis for pre- and posttest designs of intact groups.

Nonparametric tests “do not specify normally distributed populations or equality of variance” (Cooper & Schindler, 2008, p. 480). The proposed study assumes that the test score distributions approximate a normal distribution. While nonparametric tests can use interval data such as test scores “they waste much of the information available” (Cooper & Schindler, 2008, p. 480).
Researchers from previous knowledge recall and technology studies have determined that some learners use internet resources and forums to acquire knowledge (Renzulli & Reis, 2007). Instructors using the Web for learning who primarily use text files to deliver curriculum may find acquisition of the desired knowledge difficult for a variety of learners. Forums that create community relationships are an important component in the knowledge acquisition process.

Clarke et al. (2005) studied the effects of technology on math students who had prior technical comprehension for using spreadsheet applications on their acquisition of knowledge. Clarke et al. concluded that ninth grade high school participants learned more effectively when they learned or already knew the technological skills that were applicable to the tasks. Conversely, attempting to use technology in the acquisition of new knowledge when students did not have a prior working knowledge of the technology required additional training on how to use the technology.

**Research Question and Hypotheses**

It is difficult to make well-informed decisions on purchasing instructional technologies for knowledge acquisition when there is little or no data on knowledge acquisition and its relationship to instructional technologies. Without information on the relationship of instructional technologies and knowledge acquisition, the decisions to invest in instructional technologies may be an inappropriate use of organizational resources. Ryu, Kim, Chaudhury and Rao (2005) stated that businesses should “spend a greater amount of resources to obtain the optimal level of knowledge under favorable conditions of high discount rate of cost, high salvage value of knowledge, large initial level of knowledge, large others' knowledge, and the productive learning process” (p. 271). This would imply that when businesses invest resources for knowledge acquisition
that individuals in the can measure the value and potential benefits of the investment beforehand. The subsequent question will guide proposed study:

R1. Is there a relationship between the use of visual, verbal, or kinesthetic instructional technologies and the score on a recognition test of study material?

An analysis of relationship between the dependent variable and independent variables will be used to test the following hypotheses:

\( H_{A1} \): There is a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material.

\( H_{O1} \): There is not a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material.

\( H_{A2} \): There is a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material.

\( H_{O2} \): There is not a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material.

\( H_{A3} \): There is a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material.

\( H_{O3} \): There is not a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material.

**Theoretical Framework**

The proposed study utilizes the findings by Witkin on field dependent and field independent cognitive styles for acquiring knowledge (Witkin, Goodenough, & Karp, 1967) for its theoretical framework. Witkin et al. suggested that cognitive styles for knowledge acquisition have a relationship in the ability of field independent students to learn independently without a social network. Many organizational and educational
leaders use the budgeting process to drive the allocation of funds to acquire technology and physical capital. The purpose of purchasing many of the instructional technologies is to facilitate the process where individuals and the organization benefit by improving knowledge acquisition.

**Knowledge Acquisition**

Research by Witkin for knowledge acquisition focused on field dependent and field independent learner (Hunt et al., 2006). Field dependent learners rely on the dynamics of the social environment. In a learning environment, students infer what information is important by looking at how the instructor presents, formats, and organizes information. Learners may sense that instructors are identifying key points for knowledge acquisition with bolded or italicized information. Other types of learners, such as kinetic learners, may use learning objects as primary activities for learning important concepts. Dependent learners that prefer to work with others gather clues from the social environment.

In higher education, researchers continue to investigate the need to improve students’ acquisition of knowledge as a function of learning styles (Bello, Knowlton, & Chaffin, 2007; Brathwaite, 2006; Mahmud, Armstrong, & Zhichang, 2004; Veenman, Prins, & Verheij, 2003). Some researchers found a relationship between knowledge acquisition and learning styles (Renzulli & Reis, 2007), whereas others have found no relationship (Overbaugh & Lin, 2006). The concept of “user-centered optimization” (Meij, 2003, p. 213), a concept that Meij (2003) developed from the theory of minimalism, which was adapted from Carroll’s (1998) theories is the theoretical framework for the proposed study. According to the concept of user-centered
optimization, learners acquire knowledge as a function of information that instructors provide in an optimal format suited to the learning style of the learner.

*Instructional Technologies*

Justification for instructional technology acquisitions in higher education and business organizations may only be hearsay in terms of the capabilities and benefits of the technology. Without evidence on the benefits and capabilities of instructional technologies, the effort to use instructional technologies to improve the student’s knowledge acquisition may fail. Past research is inconclusive on the benefits derived from purchasing instructional technologies. Learners in certain settings and situations have benefited from instructional technologies in knowledge acquisition whereas other learners have not (Gerjets, Scheiter, & Schuh, 2008; Zhu & Baylen, 2005).

Several researchers asserted that purchasing and adopting new instructional technologies in themselves does not lead to higher levels of achievement and that an individual’s learning style is key to improving knowledge acquisition (Beyth-Marom, Saporta, & Caspi, 2005; Dennan, Kennedy, & Pisarski, 2005; Muthukumar, 2005; J. F. Yang, 2006). Beyth-Marom et al. (2005) stated that “learning environments that suit some students do not satisfy others” (p. 260) for satellite-based synchronous tutorials and satellite- based asynchronous videocassettes. Dennan et al. (2005) declared that there is an indirect relationship between a flexible learning system in an online environment and performance outcomes for university students in an undergraduate management course. Using the principles of cognitive load theory in the design of “complex representations of information” (p. 49) for multimedia presentations promotes meaningful learning. J. F. Yang (2006) stated that “adopting the newest distance media does not always result [in] increased learning outcomes or achievement” (p.130).
Other researchers indicated that technology contributes to higher levels of achievement and knowledge acquisition (Assimakopoulos & Yan, 2006; Flowers, Pascarella, & Peirson, 2000). Chinese engineers seeking to acquire knowledge for daily work needs, like university students, read content specific books and browsed the Web. Chinese engineers use “specialized Internet software technology forums” (Assimakopoulos & Yan, 2006, p. 103) because knowledge that is more complex is not available within local professional circles. Flowers et al. studied second-year college students and stated that when instructors assigned activities that included the use of computers and technology, the benefits had “positive impacts on composite cognitive development and reading comprehension, and, to a more modest extent, on critical thinking” (p. 663).

Learning Styles

Unique learning styles as a concept dates back to the work of Johann Friedrich Herbart in the early 1800s (Blyth, 1981). Herbart was chair of philosophy at Königsberg University where he initiated a post secondary teacher training program in 1809. At about this time, Herbart observed that students did not acquire information informally in the traditional lecture pedagogy. Blyth (1981) stated that Herbart recognized “children had different dispositions (Anlagen) which must be taken into account, when the process of pedagogy is undertaken” (p. 71).

Matching the design and delivery of information to suit learners in a Web-based instruction delivery mode begins with identifying an appropriate “interface design” (Meij, 2003, p. 214). A. Gilley and J. Gilley (2006) found a correlation between delivering information in a format that matches the learners’ learning style and knowledge acquisition. Focusing on the opposing types of learning styles for “visual
versus verbal” (Bacon, 2004, p. 205), presentation, format of information is significant when addressing the demands of the students’ learning style.

Learners who need visual aids for processing information into knowledge can utilize files that include graphs, diagrams, and images. Verbal learners who need to hear clarification for knowledge acquisition can use files embedded with audio explanations. Bacon (2004) stated that the “active versus reflective” (p. 205) learning style is identified as learners who acquire knowledge by practicing activities, such as by learning objects or hands-on activities as opposed to learning by reflecting on the recently accessed information. Learners receive feedback on success and failure virtually immediately using learning objects and hands-on activities. Learners with reflective styles prefer to think about and cognitively digest information presented earlier and are competent at reading text files in solitude and contemplating how the information is relevant to personal experiences that form long-term knowledge (Bacon, 2004). Finally, “sequential learners” (Bacon, 2004, p. 205) prefer information designed and presented in a linear pattern.

Mayer and Moreno (2003) suggested that successful delivery of information with technology in a multimedia environment is dependent on the cognitive load of the individual learner. There are three theories that affect the ability of the mind to acquire knowledge effectively: the “dual channel assumption, the limited capacity assumption, and the active processing assumption” (Mayer & Moreno, 3p. 44). Simultaneously presenting information in multiple formats, such as audio and text, requires knowledge acquisition to occur by learners listening and seeing. Learners are required to process information through human sensory channels and as a mental process for creating knowledge, which has the potential to overload the learner’s capacity for knowledge
recall if multiple formats are used to present information (Paivio, Walch, & Bons, 1994). For knowledge acquisition, the learning style channel has the ability to receive a limited amount of information before the process of knowledge acquisition begins to shut down. Thus, accommodating multiple learning styles requires balance by reducing or separating information presented in a multimedia format.

As stated in the limited capacity assumption the throughput capacity of the learner is restricted to each learning channel’s capacity (Mayer & Moreno, 2003). Throughput capacity is the maximum amount of information that learners are capable of digesting during an instructional session. A learner’s capacity to acquire knowledge as a function of the throughput capacity diminishes when the process of knowledge acquisition simultaneously processes information through multiple channels (Mayer & Moreno, 2003). Barrett, Tugade, and Engle (2004) addressed the attention span that learners exhibit in the knowledge acquisition process in their working memory theory.

Information presented in a visual format will excite different sensory memories in each learner. Given that learners will recall a variety of sensory memories that differ in quantity and quality of experiences, a challenge arises when trying to determine what constitutes too much channel information, which would cause learners to have problems maintaining attention. When learners experience excessive channel information, this has a relationship to the active processing assumption in the “selecting-organizing-integrating theory of active learning” (Mayer & Moreno, p. 44).

When learners actively process new information with prior knowledge, this combination can improve the learner’s knowledge acquisition. Active processing and the individual’s future ability to recall the new information diminishes following breaks or
loss of attention. As an interrelated process, knowledge acquisition lessens as a nonlinear function of problems in dual channel processing and the limited capacity function.

Definition of Terms

The section for definition of terms provides definitions for words to assist in the readability and comprehension of the study. Related to the subject of cognition, knowledge acquisition, and learning styles, the section covers the technical terms used in the study. The section also operationalizes independent variables used in the study.

Active processing: Mayer and Moreno (2003) referred to active processing as “a substantial amount of cognitive processing to take place in the verbal and visual channels” (p. 44). Active processing is a cognitive activity that occurs when learners integrate and catalog new knowledge with prior knowledge. Active learning processes incorporate “paying attention to the presented material, mentally organizing the presented material into a coherent structure, and integrating the presented material with existing knowledge” (Mayer & Moreno, p. 44).

Cognitive load: Sweller, Merrienboer, and Paas (1998) referred to cognitive load as the “limitations of the human working memory” (p. 252). Yeung (1999) determined that cognitive load is a variable that fluctuates to the “extent that mental resources are readily available for information processing” (p. 213). Cognitive load is the amount of knowledge that the mind is attempting to process at any given time. Components of cognitive load are the magnitude and elements of information processing that occur with categorizing, contrasting, and evaluating the knowledge with prior knowledge.

Degree Status: Degree status is measured as seeking a business related degree or another non-business related degree.
Dual channel: Mayer and Moreno (2003) identified dual channel as internal conduits where processing of information occurs simultaneously through more than one sense. Human senses that process information are auditory, visual, and kinesthetic. Mayer and Moreno synthesized from research in cognitive science that the “human information-processing system consists of two separate channels—an auditory/verbal channel for processing auditory input and verbal representations and a visual/pictorial channel for processing visual input and pictorial representations” (p. 44).

Kinesthetic: A kinesthetic process is the method of “getting physically involved in whatever is being learned” (Russell, 2006, p.351). As a learning style, it is through the learner’s ability to sense physical changes in the arrangement of appendages, such as the movement of hands, legs, or arms that promotes knowledge acquisition.

Kinesthetic activity: The independent variable kinesthetic activity is measured as an ordinal variable by the WebCT instructional technology system.

Kinesthetic learners: Learners who desire “to use their whole body to learn; they retain information by practicing demonstrations or procedures” (Billings & Halstead, 2005, p. 30).

Minimalism: Meij (2003) identified minimalism as the process where instruction “presents the bare minimum at the moment when users need it (a ‘just-in-time’ presentation)” (Meij, 2003, p. 215). Minimalism refers to the processes of eliminating unnecessary or distracting forms of learning that inhibit the process of knowledge acquisition.

Minority status: Ethnic categories limited to Native American, Asian, and African American identify the minority status of the research participants.
Educational major: Scholarly discipline in which a student is seeking an associate degree or certificate identifies the educational major of the research participant.

Modularized learning objects: Robson (2002) identified modularized learning objects as types of learning objects that “can either stand alone or be used as part of larger units of learning” (p. 18). Stated another way, modularized learning objects refer to knowledge organized as a self-contained unit designed to assist learners in the process of knowledge acquisition. Modularized learning objects can be hands-on activities or short audio, text, or image files.

Programmed learning: Ansalone & Ming (2006) defined programmed learning as a self-initiated process for a learning structure where a learner completes individualized steps and activities successfully to build knowledge before proceeding to the next step.

Test of Understanding in College Economics (TUCE): The pre- and posttest instrument used to measure the dependent variable for knowledge recall.

Throughput capacity: Lerher, Sraml, Kramberger, Potrc, Borovinsek, and Zmazek (2006) defined throughput as the maximum output as a volume or quantity of output that a system could produce. Throughput capacity is the limitation in acquiring knowledge that learners experience relative to the quantity of knowledge that learners attempt to process in a given time.

User-centered optimization: Meij (2003) defined user-centered optimization as the dissemination of knowledge designed in a text, audio, or image packet that optimally matches the learning style needs of the student.

Verbal activity: The WebCT version 3 instructional technology system measures the independent variable verbal activity as an ordinal variable.
Visual activity: The WebCT version 3 instructional technology system measures the independent variable visual activity as an ordinal variable.

WebCT version 3: This is a software program designed to be user-friendly for the “delivery of course content” (Roqueta, 2008, p. 59) using the internet.

Assumptions

After reviewing the first chapter of the textbook that contains an appendix on graphing, research participants in the college economics course should have a minimum knowledge of graphing capabilities. During completion of the college economics course, research participants must successfully read and analyze graphs to calculate marginal events, supply and demand information, revenue and cost information, and profit maximization for all forms of business structures to pass the course. An example of analyzing graphs is the requirement to convert tables of information into graphs in order to determine the opportunity cost of different alternatives or the output that maximizes profits for different organizations.

For the proposed study, the researcher assumes the majority of research participants will give their best efforts when reading and answering the questions for the pre- and post-assessments. Hoyt (2001) stated that for community colleges “68 percent of the students nationally gave the English assessment their best effort, and 52 percent gave the critical thinking exam their best effort” (p. 79). Research participants will have the appropriate English skills necessary to understand the questions.

After a brief explanation of the different learning activities that will be available to the student, research participants will know what type(s) of formatted instruction best fits their learning style. D. Zhang (2008) recommended that instructors provide a brief description of learning styles, which complements student behavior where “all students
will have at least some activities that appeal to them based on their learning styles, and they are more likely to be successful in these activities” (p. 26). With the instructor presenting information in all three formats (i.e., visual, auditory, and kinesthetic), the research participants should utilize the appropriate material. Research participants should not try to access all the material, as assessing all the course material could create a potential for cognitive overload. When students chose a learning style that does not match their preferred learning style learning may diminish “because the experience of discontinuity can be very threatening, particularly when students are weak in these areas” (D. Zhang, p.28).

In the event that students do not own a computer with Web access, the assumption is that students will have the time, resources, and technological skills to use college computers and programs to access the instructional materials. Research participants should be familiar with navigating through the Web-based program to find and utilize the material. After a few instances of using the instructional files, the time to navigate to the desired material is approximately the same amount of time for each research participant.

WebCT Vista 3, the Web-based system that is included in the proposed study will measure the time increments spent on content pages, but will not measure if the student is engaged actively in learning the content. Many distractions could cause the student to begin a session and subsequently leave the learning environment. Students will utilize the instructional content that assists the learning process the most, if the student considers study time as valuable. Use measured by the instructional technology should reflect only the usage needed to improve knowledge acquisition.
Scope

The scope of the study will include students enrolled in the Macroeconomics and Microeconomics courses at Coconino Community College in Flagstaff, Arizona. The proposed study will be limited to a random sample of the population of Macroeconomics and Microeconomics courses at Coconino Community College. To determine the subset of the population a convenience sampling process will be used. Creswell (2005) stated that a convenience sampling process is a “quantitative sampling procedure in which the researcher selects participants because they are willing and available to be studied” (p. 590). In addition, the proposed survey will include existing questions from the TUCE.

The independent variables include age, gender, minority status, educational major status as business or non-business, technological experience, and the use of visual, verbal, or kinesthetic activities. Students will self-report the variables of age, gender, minority status, educational major status as business or non-business, and technological experience. To self-report students will use a student survey. WebCT Vista 3 will measure the use of visual, verbal, or kinesthetic activities. The dependent variable is the students’ score on the TUCE pre and posttest.

Limitations

Limitations include the potential “loss or lack of participants, small sample sizes, errors in measurement, and other factors typically related to data collection and analysis” (Creswell, 2005, p. 198) that are beyond the control of the researcher. The limitations that influence the proposed study will be that the demographic features represented by the students who voluntarily agree to participate in the study may not be representative of other student populations. The collection of demographic data relies on the research
participant to accurately report for age, gender, minority status, technological experience, and major status.

Some activities for learning economics may be easier for some students to learn from because of the student’s personal experiences. The ability of the producer of the Web-based economic material to meet effectively the various learning style needs of the research participants limits the proposed study. WebCT Vista 3, the Web-based delivery system measures time increments that students access course content pages, but cannot monitor if the student is engaged in learning the material. This limitation means that use of the learning activities may include usage where the student is not actively engaged in learning.

Validity of the proposed study will be limited to the quantitative correlational research design. The correlational research design measures the “degree of association (or relationship) between two or more variables or sets of scores” (Creswell, 2005, p. 325) and may more directly be able to answer the research question than other types of quantitative analysis. Research will be limited to the study begin and end dates artificially set by the semester calendar and subject to set holidays, breaks, and other temporal interruptions that influence the pace of instruction, the teacher, and the participants. These temporal interruptions may influence the student’s ability when taking the pre- and the posttest.

Delimitations

A delimitation for the study is that students will be limited to one college and one geographic location. A survey of visual, verbal, or kinesthetic instructional technologies usage by students enrolled in the Macroeconomics and Microeconomics courses at Coconino Community College is a limitation of the proposed study. Therefore, the focus
will be on knowledge acquisition of economic concepts and may not be applicable to other disciplines.

For the proposed study, the research will be limited to results based on the application of Web instruction, whereas using other media may produce different results. Only students 18 years of age and older enrolled in the college Microeconomics and Macroeconomics courses with a student ID and password will have access to the material. The proposed population of students and the results may not be applicable to other content areas or the population in general.

Summary

For the proposed study, the chapter 1 introduced the problem facing education and business organizations, specifically regarding the purchase of instructional technology despite insufficient information about its relationship to acquisition of knowledge. Improved acquisition of knowledge could represent a positive return on investment, which assists in the justification of budgeting for the purchase of instructional technologies. Research, not marketing, is needed for validating return on investment for knowledge acquisition, which could be valuable in the decision making process for acquiring instructional technologies.

Some researchers attempted to show that because of the benefits of instructional technology, there might be possibility to improve the acquisition of knowledge with instructional technologies (Lévesque, 2006; Paquin, 2002; Turmo et al., 2006). Like productivity software, instructional technologies continue to provide new features with each version that enhances the perceived value and ability of the technology to improve knowledge acquisition. There is a benefit if the information delivered through instructional technologies improves knowledge acquisition by delivering information that
meets the learners’ needs. Those benefits may match or exceed the investment in instructional technologies.

Witkin provides insight into the learner’s knowledge acquisition characteristics (Kang, Scharmann, Noh, & Koh, 2005) in the independent and dependent cognitive learning styles. Bacon (2004) focuses more on the human senses by providing additional insight into knowledge acquisition through the identification of visual, verbal, active, reflective, and sequential learning styles. Mayer and Moreno (2003) indicated that learners are limited to the amount of knowledge acquisition that takes place as a function of cognitive load.

For the proposed quantitative correlational study, the purpose will be to determine if developing curriculum with audio, visual, and kinesthetic activities and delivering it with instructional technologies has a relationship with knowledge acquisition of learners. To determine the relationship between utilizing instructional technologies delivered by Tegrity, a whiteboard instructional technology and a Web-based instructional technology, and acquisition of knowledge the proposed study is suited to use a quantitative correlational design. The study may add to the organizational leadership’s decision-making process for allocating resources for technology to affect organizational knowledge acquisition. Instructors may also determine the degree that structurally developed curriculum delivered by technology has a relationship with knowledge acquisition.

Chapter 2 focuses on the literature review that assists in understanding what constitutes knowledge, what influences knowledge acquisition, and how knowledge acquisition occurs. To understand knowledge acquisition in this context, it is important to investigate the literature on cognitive theory and learning style theory. Embedding
instructional pedagogy into technology to deliver curriculum requires an investigation into the literature of educational applications of technology.
CHAPTER 2: REVIEW OF THE LITERATURE

The purpose of the proposed quantitative correlational study is to examine the relationship when students use visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and acquisition of knowledge, as evidenced by scores on pre- and posttests. For centuries, humans have been intrigued with ways that the mind acquires knowledge. Plato states that knowledge is either “acquired at some time, or else possessed always” (Jowett, 1875, p. 288). Humans have the ability for using priori knowledge, which Plato rationalizes from the observation that “without anyone teaching him he will recover his knowledge for himself, if he is merely asked questions” (Jowett, 1875, p. 288). The framework for chapter 2 includes the scope of literature reviewed, historical review of knowledge, cognition, knowledge acquisition, learning styles, technology, conclusion, and summary.

Title Searches, Articles, Research Documents, and Journals

Peer-reviewed articles and books on knowledge acquisition, cognition, learning styles, instructional technology, learning environments, and pre- and posttest assessments were read. Many articles covered more than one topic. Most peer-reviewed articles are from the University of Phoenix (UOPHX) EBSCOHost, ProQuest, Gale, UOPHX Dissertations & Thesis, and UOPHX specific publication library search engine. Additionally, books, textbooks and peer reviewed journals were consulted for information related to technology, knowledge acquisition, cognition, and learning.

Table 1 lists the peer-reviewed journals, textbooks, books, and dissertations related to the research question and research topic. The analyses of all items reviewed are as follows: (a) 286 related peer-reviewed articles, of which 182 were cited; (b) 5 dissertations, (c) 30 books and textbooks, (d) 5 web related articles. Of the 223 cited
references, 135 were published in the last five years. A sample of four dissertations on knowledge acquisition published in 2008 at the University of Phoenix revealed that the number of current articles cited was 87, 87, 179, and 92 for an average of 111 current articles. While the proportion of current articles cited for the proposed study is approximately 61%, the total number of articles cited, when compared to other recent and related dissertation, is adequate for the investigation into the topic of knowledge.

Table 1

Summary of Literature Reviewed for Proposed Study

<table>
<thead>
<tr>
<th>Topic</th>
<th>Peer-reviewed articles</th>
<th>Doctoral Dissertations</th>
<th>Books</th>
<th>Web related</th>
<th>Total</th>
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<td>1</td>
<td>46</td>
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<tr>
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<td>7</td>
<td>1</td>
<td>54</td>
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<tr>
<td>Learning Styles</td>
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<td>1</td>
<td>3</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
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<td>1</td>
<td>3</td>
<td>4</td>
<td>87</td>
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<tr>
<td>Learning Environments</td>
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<td>1</td>
<td>11</td>
<td>19</td>
<td></td>
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<tr>
<td>Pre- and Posttest Assessment</td>
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<td>3</td>
<td>1</td>
<td>17</td>
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</tr>
<tr>
<td>Knowledge</td>
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<td>36</td>
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<tr>
<td>Learning Objects</td>
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<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Unduplicated Total</td>
<td>286</td>
<td>5</td>
<td>30</td>
<td>10</td>
<td>331</td>
</tr>
</tbody>
</table>

Historical Overview

Aristotle recognized that man could acquire scientific knowledge but that there must be a foundation of “better knowledge of the basic truths” (2004, p. 6) and more than
perception to validate knowledge. Almost 2,000 years later, philosopher John Locke (1838) stated that perception is the initial contact we have with knowledge and is unavoidable in the process of forming knowledge. Changing the philosophical ideology was a dramatic paradigm shift for John Locke from what Plato and the medieval philosophers believed. Current beliefs of knowledge include an understanding of how knowledge is socially constructed (Lang, 2001) and the relationship between learning styles and technology in developing knowledge.

Defining Knowledge

In an *Essay of Human Understanding*, Locke declares that there are “two fountains of knowledge, from whence all the ideas we have, or can naturally have, do spring” (p. 51). External objects produce knowledge from which human senses “convey the perception of things” (Locke, p. 51). Finally, the last form of knowledge consists of the processes of the mind to perceive how things work not from observation, but from reflection using our powers of “thinking, doubting, believing, reasoning, knowing, willing and all the different actings of our own mind” (Locke, p. 51).

Epistemology, known as the study of knowledge, specifies the origins, reality, and explanation of knowledge. In Plato’s recorded dialogues, Plato identified the desire to explore knowledge and believed that the structure of knowledge included the concepts of fact, conviction, and rationalization (Moser & Nat, 2002). Knowledge consisted of “forms,” (Moser & Nat, p.35) which Plato recognized as ideas that society long had accepted as absolute. The defense for rejecting the idea that sensory observation constituted knowledge was the suppositions that “all sensory objects are changeable” (Moser & Nat, p. 35) and that because knowledge is unchangeable, then sensory observation must not be knowledge.
Philosophers of the “classical modern philosophy” (Moser & Nat, p. 111) period from approximately 1600 to 1800 challenged Plato’s explanation of knowledge and advanced the theory of empiricism. Aristotle believed that Plato’s forms were too narrow and that there was “no single science of the good, and hence, no Idea (Form) of the Good” (Putman, 2008, p. 18). Aristotle contradicts Plato concluding “there are many intrinsic goods, for example, intelligence, seeing, certain types of pleasure” (Putman, p. 18) that contribute to knowledge. Belief that humans could recognize knowledge as an observation through the senses and could articulate from observation, facts, definitions, principles, concepts, or processes, changed the concept of knowledge from one of a belief to one of knowledge (Moser & Nat).

Rene Descartes, a rationalist, and Immanuel Kant, an empiricist, rejected the concept that knowledge only originates out of undeviating consciousness (Moser & Nat, 2002). Contrary to Plato’s rationalist position, the new philosophical theorists attempted to explain that recognition of knowledge does occur through the senses (Moser & Nat). Descartes validated knowledge as the ability of humans to “indirectly represent the world through sensory experience and conceptualization” (Moser & Nat, p. 109). Descartes rationalized that an idea is factual given the explicit provision that the supporting arguments are clearly related. Kant extended the importance of the senses and rejected that humans have universal priori knowledge of the environment and must construct reality and knowledge through the sensory perception, which is “shaped by and inextricably linked to his/her experiences” (Curry, Meyer, & McKinney, 2006, p. 34).

In the 1900s, philosophers including Bertrand Russell and G. E. Moore shifted attitudes, transitioning to a combination of the ideas of both the empiricists and the rationalists (Moser & Nat, 2002). Russell and Moore theorized that individuals develop
knowledge because new experiences stimulate the human senses. From the empiricist viewpoint, “empirical evidence of the senses … visual, auditory, tactile, or gustatory experiences” (Moser & Nat, p. 195) was essential to validate knowledge as legitimate. As rationalists, Russell and Moore maintained that prior knowledge does exist outside the experiences that constitute knowledge.

By the 1920s, the philosophy of knowledge changed again. As logical positivists, Wittgenstein, Carnap, and Ayer supported the extreme perspective of empiricism and rejected the claim that knowledge existed in priori knowledge, thus defining the positivists’ “principle of verification regarding meaning and understanding” (Moser & Nat, 2002, p. 218), which is seen as necessary for scientific proof. Modern thinkers possessed knowledge about quantum mechanics, where “objects are known to exist but are beyond the human senses” (Pearce, 2005, p. 35) that contradicted the extreme position of the positivists. Entering the twenty-first century, philosophers generally aligned themselves on a continuum between the empiricists and idealists’ viewpoints.

At the end of the twenty-first century, philosophers begin to argue, “knowledge is both produced and held collectively rather than individually” (Lang, 2001, p.43) meaning society socially constructs knowledge. As society embraces new communication and participation models like open source software development, Wikipedia, and the Human Genome Project, “practitioners see the logic of each other's thinking in communities brought together by common interests” (Lang, p. 43). New models of collaboration continue to evolve as businesses and individuals realize the intrinsic and extrinsic value of using the Web to access the knowledge of millions of people. Crompton (2007) contextualized socially constructed knowledge as a “new post-academic model of innovation [that] has emerged due to societal changes, where contextual knowledge is
socially constructed and integrated” (p. 202). Socially constructed knowledge evolves as technology improves because “people usually talk in person, on the telephone, and via e-mail and groupware to share expertise and solve problems together” (Lang, p. 43). Regardless of the societal barriers for inclusion, technology offers an opportunity where a “disenfranchised group of laypersons have organized themselves into representative lobby groups contributing, as equal partners, their expert knowledge” (Crompton, p. 209).

Knowledge Acquisition

Acquiring knowledge is a process that flows from information that combines with “justified true belief” to produce either “explicit knowledge” or “tacit knowledge” (Nonaka & Nishiguchi, 2001, p. 13-14). Faith is the justification that knowledge exists in the absence of observable experiences and measurable events. Thomas Aquinas recognized the difficulties of faith and absolute knowledge, stating, “we cannot acquire truth from the incorporeal senses” (Moser & Nat, 2002, p. 38). Using chess Chase and Simon (1973) investigated the process of knowledge acquisition by studying the ability of individuals to distinguish critical components of a problem and to focus cognitive skills on solving the problem,

Chase and Simon’s chunking theory explains the phenomenon that permits individuals to recognize critical components in the problem solving process. Gobet (2005) proposed that knowledge acquisition is a maturation process over time of a “discrimination network giving access to long-term memory” (p. 185). Discriminate knowledge provides learners with knowledge for the decision-making process to avoid known causes of failure based on personal experiences. For future use, the process of chunking memory as discriminate knowledge complicates the initial process for
comparing, cataloging, and analyzing information when “presenting a narrow range of problems” (Gobet, p. 197).

Chess as a game separates players according to the individual’s skill level. Skills needed for analyzing, problem solving, comparing, and cataloging categorize a player as a beginner, expert, or somewhere in between. Each of the two players has 16 pieces to control and has a possible count of 32 pieces to analyze for potential movement.

With short-term memory capable of processing “seven plus or minus two pieces of information” (Zaichkowsky, 1991, p. 54) there are limits to the number of potential moves that the player can process (Chase & Simon, 1973). G. A. Miller (1956) defined short-term memory as stimuli that, in the process of mental analysis to find associated memory patterns, learners observe as a “one-dimensional judgment” (Absolute Judgments of Multidimensional Stimuli section, ¶ 1). A one-dimensional judgment reduces the number of competing variables for comparison to one. Knowledge acquisition as a repetitive process incrementally moves chunks of knowledge from short-term memory into long-term memory, allowing individuals to handle large amounts of information that are now multi-dimensional (G. A. Miller).

Lutz (1995) departed from the theory that learners acquire knowledge as a repetitive process in developing the syncretistic theory, which Lutz postulated the use of immersion as “effectively add[ing] to the students’ knowledge base” (p. 12). The types of engagement found to be effective included “historical, personal, visual, and reflective” (Lutz, p. 12) immersions. Using the visual learning style students read textbooks and learn from the readings, which is similar to the historical immersion. Historical immersion as a pedagogy expands the topic of study to include related events that occurred during the same historical era. Teaching students about Adam Smith’s invisible
hand, which is the motivation that humans innately possess in a free market to make decisions that are in one’s best interest, is a fundamental economic concept. In the context of historical immersion, an instructor has students read about the economic events in Europe and England that contributed to the discovery of the invisible hand.

Students may use a combination of learning styles to acquire knowledge. Visual immersion may be a combination of visual and verbal learning styles. Visual immersion utilizes all forms of video presentations. Movies, audio presentations, or multimedia presentations that reinforce curriculum objectives can include visual immersions. Teaching the art of negotiation, the instructor might use the jury’s deliberation for a murder trial in the film 12 Angry Men.

Instructors engage students in journal writing through reflective immersion, which is a process that clarifies in the author’s own words concepts that are relevant to the curriculum. For reflective immersion, instructors may have students participate in service learning projects and volunteer time to organizations. Using student projects, the objective is for students to practice the knowledge they learned as part of the classroom instructional activities and to journal their experiences. A goal of the experience is for students to reflect and reinforce the instructional activities in the context of a real world environment.

Personal immersion is similar to reflection when students use acquired knowledge to reinforce understanding of instructional activities. Personal immersion utilizes role-playing, where students imitate the learning objective. Imitation requires the participants to have a deeper understanding of the motivations that cause individuals to act in a particular manner. In leadership curriculum, role-playing conflict resolution situations deepens the comprehension of the objectives for managing conflict resolution.
A mechanism for developing and nurturing knowledge is managing a healthy communication channel where knowledge acquisition minimizes the limitations of the brain’s working memory (Schär & Zimmermann, 2007). Sharing information and knowledge in a manner in which both parties feel safe is an essential part of the communication channel. Organizational members promote knowledge acquisition when “both the individual task performer and other organizational members are expected to develop knowledge on new solutions in common” (Nonaka & Nishiguchi, 2001, p. 43). Determining if knowledge acquisition occurs often requires the use of assessment.

**Assessing Knowledge Acquisition**

A common assessment tool for knowledge acquisition is the multiple-choice test (R. Cohen & Swerdlik, 2005). Based on students’ results on an examination, instructors may evaluate the chosen instructional pedagogy. Multiple-choice examinations’ validity and reliability must follow standard writing guidelines, else the examination may “add construct-irrelevant variance to the test” (Stagnaro-Green & Downing, 2006, p. 566). Construct-irrelevant variance (Haladyna, Downing, & Rodriguez, 2002) is a term for producing questions that are unnaturally tricky that can reduce the average score and therefore fail to measure accurately knowledge acquisition. Haladyna et al. developed the item-writing guideline taxonomy of 31 items for constructing multiple-choice questions.

Another assessment tool is the short-answer or essay question examination. Short-answer questions prompt students to respond creatively. Instructions for completing short-answer or essay questions should provide clues or a rubric for rating the answer. Hecker and Violato (2006) tested the validity of the short-answer question and determined that a “clear rubric with specific criterion for the marking scale and training on the scale for raters should improve interrater agreement” (p. 310).
Cognition

Defining Cognition

Cognition represents the ability of people to acquire an understanding or knowledge of information. It is also the dependent variable for the proposed study. Individual cognitive styles and personalities are used for problem solving, recollection, perception, and reasoning (Cherkes, 1983; Rayner, 1997; Sadler-Smith, 1999). Each person possesses a unique blend of cognitive characteristics, thus making each cognitive style as different as a thumbprint.

A dynamic external environment continually influences the learners’ cognitive styles (Rayner, 1997). One such external matter is the influence of technology. Kirton (1976) adopted the term Adaptor-Innovator cognitive style. When technology is used by learners’ to gain “an ability to ‘do things better’ to an ability to ‘do things differently’ ” (p. 622) in such situations, learners’ must either adapt or innovate to acquire knowledge.

For the adaptor, the technological influence of sophisticated programs may be the reason for using technology. For the innovator, one reason may be the continued evolution of technology to interact in new ways to share and process information and knowledge. Major categories of learning styles that affect cognition are active, sensing, visual, and sequential, and each are centered on taking advantage of strengths of the senses and cognitive patterning (Genovese, 2004; Rayner, 1997).

Witkin’s work on perception is the most cited of the major authors on cognition (Desmedt & Valcke, 2004, p. 451). His research on perception identified two distinct cognitive styles: field-independence and field-dependence. How an individual creates perceptions of an event is the distinction between the two styles. Field-independence style is learner-centered and focuses on the self to provide the foundation for the
development of one’s perceptions and changes in cognition. Field-independence minimizes the ability of others to impact the way an individual creates cognition. In a team or an unstructured collaborative learning environment, field-independent learners would have difficulty gaining any potential benefit from other individuals that possess information.

Desmedt and Valcke distinguish field-independence learners as creating perception where “parts of the field are experienced as discrete from the background” (p. 453). In an environment of change, field-independent learners separate themselves from the uncertainty of change to foster learning. As an example, the employee involved in the merger of two companies might use historical accounts for analyzing continued employment or the need to search for another job. To minimize the need for separation by field-independent learners, an instructor should create a structured learning environment that creates the perception that the information possessed by other learners has value (Endler, 2000).

Learners who seek understanding and cognition out of the context of the learning environment are field-dependent learners. For field-dependence, the overall environment is the primary influencer in the development of perceptions (Desmedt & Valcke, 2004; Endler, 2000). Desmedt and Valcke identified field-dependent learners as creating perception when the environment is “strongly dominated by the overall organisation of the surrounding field” (p. 453). Learners who depend on the environment for supporting the field-dependence cognitive style require a stable environment in which to construct understanding. Comparatively, the business that is in constant flux and in a condition of chaos is unstable, and the ability of the organizational and educational leadership to learn and to react using rational decisions becomes diminished. Although controlled chaos can
be beneficial to an organization as it remakes itself (Wheatley, 1999), chaos is disturbing to some participants in the environment.

Perry (1970), in a study of college students, stated that the process students use to cope with chaos and acquire knowledge is a linear framework that identifies nine progressive positions for cognitive development. Perry grouped the nine progressive positions into the three general positions of dualism, multiplicity, and relativism. Students often begin as freshmen viewing information and issues as right or wrong with no gray areas. Perry referred the first two positions as dualism in which students view knowledge as complete and a correct answer exists for every question.

As students migrate to Perry’s (1970) next two positions of multiplicity, they accept that in certain instances there is no perfect answer. Interpreting issues that were once black or white, students now identify gray areas that may begin to constitute personal opinion. As students progress from multiplicity to relativism, a level of intellectual analysis develops. Given that knowledge is not complete and some information may be opinion, students begin to seek defensible patterns. When interpretations are incongruent with prior patterns, students begin a process of negotiating with the instructor. In similar ways, students create comfort in knowing the conditions or expectations for assessing performance and become frustrated, disenchanted, demoralized, and defensive when assessment of knowledge is subjective and malleable (Mpofu & Imalingat, 2006).

Within Perry’s (1970) three positions of relativism, students begin to question any knowledge as absolute. Students that view knowledge as gray, but learn to choose and defend a position, then migrate to the final position of relativism. Students begin to use the knowledge and skills acquired as a rational process to voice opinions and beliefs in
the final position of relativism. Students reaching the last position have learned to self-assess opinions, beliefs, and interests as a rational process so that the result is to either discard or reserve the self-assessments.

Learners may adapt as instructors change and modify the learning environment by using either field-dependence or field-independence cognitive styles. However, learners may develop at an early age an affinity toward a specific cognitive style (Kagan & Henker, 1966). Kagan and Henker showed that early age preferences for field-dependence or field-independence became stronger over time. In addition to a tendency for a cognitive style, preferences over time become persistent as a “personality-related individual way of organising and processing information” (Desmedt & Valcke, 2004, p. 454). Repetition and reinforcement from the success of a selected cognitive style make it more difficult to “adapt to new styles of learning” (Guri-Rosenblit, 2005, p. 21) possibly leading individuals to exhibit signs of stress during learning episodes. Organizing information visually requires individuals to have some need for spatial referencing (Kurylo, Allan, Collins, & Baron, 2003; Spielmann, 2001).

Researchers studying cognition in visual perception purported concern that tendency to adopt visual cognitive styles do not relate to changes in academic achievement (Larsen & Hammill, 1975). Further, S.C. Larsen and Hammill looked at the presumption that the spatial/perception reasoning style precede the ability to adopt a linguistic/logical reasoning style (Cherkes, 1983). As most college curricula is based in a linguistics delivery system, the implication is that consideration for spatial/perception is addressed adequately within the design of the course. Creating a learning environment forcing students to adopt a learning style other than students’ innate tendency for learning can be an avoidable situation with properly developed curricula. Creating a learning
environment that attempts to maximize cognition requires consideration of which modalities are efficient in creating the right learning environment (Durham et al., 2007). Success as an economics student may be a partial function of visual, verbal, or kinesthetic learning styles.

L. Zhang (2004) showed that a hierarchical thinking style has a relationship to cognition among students in 10 curricular subjects, including economics. Students “for almost all educational systems” (Zhang, 2004, p. 364) use the hierarchical learning style to attain levels of academic proficiency. After controlling for variables of age, gender, and grade level of the student, Zhang additionally concluded other culturally influenced learning styles change academic achievement. Problem solving, a skill needed throughout life, is considered in some cases to have a greater importance than the information and skills instructors teach (Raya & Fernandez, 2002).

Kirton (1976) determined that problem solving is a function of the ability to either innovate or adapt to what the learning environment offers. In the online learning environment, problem solving is an integral part of the learning process as “participants solving problems via computer conferencing rated the quality of group problem solving processes higher” (Luppicini, 2007, p. 149) than other problem solving environments. Like in the case of field-independent/dependent learners, the environment plays a role in the ability to create understanding and solutions to problems.

When students innovate to solve a problem, they treat the environment as a variable within the context of the problem. When a student ignores the environment, much like the field-independence cognitive style, and solves problems with little consideration of the impact caused by the environment, that student is an adaptor. There is a possibility that a learner’s consideration diminishes for the environment's role in the
problem in a controlled or structured situation. Kirton (1976) determined that people are not necessarily disadvantaged in having a tendency to subscribe to one style over another but that both field-independence and field-dependence styles help to create a perception about the problem. A controlled or structured approach to problem solving then becomes part of the personality much the same as dedication to studying new information to obtain a certain level of proficiency.

Studying is the act of reviewing information as part of a methodology to learn new material such as facts, processes, or procedures. A common belief is that for students to gain sufficient knowledge to perform at a certain level of proficiency, some level of studying is required. Various processes students use are highlighting and reviewing the important material, creating note cards or flash cards, taking notes, and working problems designed to reinforce specific course outcomes. Studying is a component in the process of cognition but the amount of time that 73 postgraduate students spent studying during a microbiology course had little predictive value on student performance (Engleberg, Schwenk, & Gruppen, 2001). Students commonly believe that study time is essential for success however; study time may have little value for performance. Thus, instructors should consider when designing a learning environment the belief systems of students.

Individual belief systems are located on a continuum between completely inflexible and completely flexible. In an inflexible belief system, the learner diminishes complexity and reduces the potential outcomes or solutions to being an undemanding style of cognitive process (Tetlock, Peterson, & Berry, 1993). Learners in the inflexible belief system give little thought to alternative solutions, reducing the potential for developing innovative solutions.
Emulating the inflexible belief system as a cognitive style the learner produces spontaneous solutions. Learners within the inflexible belief system may develop a rigid tendency that creates a personality that becomes defensive at the suggestion of alternative solutions. As a cognitive style, it often is associated with a person who is over-confident, who sees solutions as right or wrong, and who has difficulty in team settings (Bailey, 2006). In contrast to using an inflexible belief system, the innovator using a flexible belief system solves problems in which environmental implications naturally make the cognitive process complicated and, thus, “tends to maximize and enhance executive functioning, which improves adaptability” (Bailey, 2006, p. 288). The extent to which the learner’s belief system is flexible allows that learner to become the innovator. Difficulties of such a flexible belief system may be the inability to resolve problems timely and efficiently, susceptibility to analysis paralysis, and a lack of sufficient convictions that cause an inappropriate level of second-guessing.

Cognitive Load Theory

Reder and Anderson (1980) discovered cognitive load theory while investigating information presented in a summarized format. Perception for many in academia is that more detail is a preferable format. Reder and Anderson found a lower performance level on memory recall assessments among participants who studied detailed curriculum than for participants not exposed to such detail. Like the clutter on a desk that makes it more difficult to find information, improved knowledge acquisition for future recall is dependent on providing a curriculum that gets to the objective without excess explanation.

As learners progress from novice to expert in knowledge, a shift occurs in the problem solving process. Novice individuals lack prior experience and, therefore, lack the
cognitive patterns to assist in the problem solving process. Novices approach the problem solving process with some expectation of an acceptable or desired outcome, known as a “means-end belief” (Skinner, Chapman, & Baltes, 1988, p. 118). Expert problem solvers rely on stores of schemas from long-term memory. As such, the individual does not suffer the limitations of schemas that one does with short-term memory and working memory.

Working memory limitations include “dual-channel assumption, the limited capacity assumption, and the active processing assumption” (Mayer & Moreno, 2003, p. 44). The dual channel assumption states that information channels first through sensory pathways (Baddeley, 1998; Paivio, 1986). Integrating audio with a presentation or text file within a multimedia environment is an example of the dual channel assumption that limits the learners’ working memory. Like a freeway with lanes of merging traffic during rush hour, pushing information simultaneously through the visual and auditory pathways reduces the learners’ capacity for knowledge acquisition.

Each sense’s capacity to handle and to process information accurately limits a person’s ability of sight and sound. A concern in the process of constructing meaning from knowledge is the effect that the senses have on perceptions and the ability to formulate meaning. Chandler and Sweller (1991) discovered that when curriculum developers present “mutually referring” information as separate visual and audible files, the information “must be mentally integrated before learning can commence” (p. 293). Presenting information in a disparate format has the effect of increasing cognitive load on the channel. As part of the processing phase for knowledge acquisition creating a set of sensory images of disparate information requires filtering. Creating this set of images increases cognitive load, which suggests that “integrated instructional formats are superior to conventional split-source formats” (p. 303).
A subset of the filtration process for new information may include the color, dimensions, geographic features, and actions within the context of the presented information. As learners access information, the capacity to place into memory every detail is limited by “active processing” (Mayer & Moreno, 2003, p. 44). When the mind fails to record details of an event into memory, the mind will fill in the gaps (Gazzaniga, 1998). Recalling knowledge requires due diligence and care to separate facts from conjecture. Further proof of the unreliability of sensory powers is the ability of the mind to visualize a sequence of events and to fill in the gaps with information it believes to be true. Like the childhood game where each person in a group whispers a message to the next person, the message often becomes barely recognizable by the time it reaches the last listener.

Roger Shepard, a psychologist at Stanford University, discovered in an experiment with colored letters that when the mind is overloaded, a state of illusion occurs where the mind adds secondary visual qualities of to complete the picture (Rehmeyer, 2007). It is critical to recognize that learners search and process knowledge. Along the way, learners make compensations for the environmental noise that can overload cognitive processing.

Learning Styles

Defining Learning Styles

In the last decade, recognition of a set of learning styles that are associated with cognition has provided further insight into how individuals acquire new knowledge. Felder and Silverman (1988) identified learning styles as using active or reflective processing, inductive or deductive classifying, sensing or intuitive awareness, visual or verbal assimilation, and that sequential patterns of learning are not mutually exclusive.
Sweller and Chandler (1994) explain in their cognitive load theory limitations for knowledge acquisition that focus on the working memory. To deliver information and improve knowledge acquisition, businesses and educators are beginning to investigate the use of new interactive technology (Baker, 2000).

Current research on learning styles points to the ability of the learning environment to provide access to the various learning styles affects the ability to acquire knowledge (Bacon, 2004; Laight, 2004). Organizational knowledge is becoming obsolete at an increasing pace, making it difficult for members to stay current with the required abilities to perform duties and assignments and remain competitive in the global marketplace (Narasimhan, Rajiv, & Dutta, 2006). When learners are flexible in accessing information in the learning environment, learners can select the delivery model that best suits a desired learning style (Gaytan & Slate, 2002/2003).

Learning styles facilitate the process of developing cognition (Felder & Silverman, 1988) as part of the progression to translate information into understandable knowledge. As a process that occurs between the variable’s information and cognition, learning styles are a necessary intervening variable in a student’s academic achievement. The way that learning styles affect cognition requires some consideration when introducing technology into education.

By modifying technology to include visual images, audio files, text-based articles, hyperlinks, and activities to reinforce patterning and inductive learning processes, instructors facilitate knowledge acquisition (Bonk & Zhang, 2006). Modifying instructional technology to include multimedia files simultaneously provides learners with the ability to use a dominant learning style. Embedding technology into the
educational process has shown to improve the performance related to higher-order 
thinking skills (Orabuchi, 1992).

*Types of Learning Styles*

Felder and Silverman (1988) identified learning styles as active, sensing, visual, 
and sequential patterns of learning, and that these learning styles are not mutually 
exclusive. Active learners develop knowledge by trying to replicate the activity 
themselves and by sharing or teaching that knowledge to others in a workgroup. Davies 
(1997) documented about the student retention benefits of cohort projects and group 
activities in the community college career and health curriculum. Student retention can in 
part be due to the relationship between cohorts and cognition, which, when measured as a 
student’s grade point average (GPA), is a statistically significant indicator of retention 
(DeBerard, Spielmans, & Julka, 2004).

Sensing learners depend on procedures based on experience to create an internal 
understanding of the learning event, work well with data, and avoid using emotion to 
generate understanding (Bacon, 2004). Visual learners utilize visual representations to 
include “pictures, diagrams, or charts” (Bacon, 2004, p. 205) to create understanding. 
Sequential learners dissect the learning event into discrete interconnected processes 
(Bacon, 2004).

Kolb (1984) defined learning as a process of knowledge creation from the 
evolution of experiences and stated that four different processes are responsible for 
creating individual learning styles. Cognitive processes for knowledge acquisition are 
concrete experience, thoughtful reflection, abstract conceptualization, and active 
experimentation.
Concrete experience learners gain knowledge through new experiences that are the product of trial and error guided by an inner awareness. Instead of using logic, the concrete experience style is dependent on emotions formed by the “involvement with people in everyday situations” (Hauer, Staub, & Wolf, 2005, p. 178). As a concrete experience, the hands-on activity presents a learning environment that promotes learning through exploration.

Dori and Belcher (2005) identified hands-on activities as an instructional pedagogy that assists learners in constructing knowledge. Successful knowledge acquisition through exploration requires the use of basic competencies, allowing consolidation of “knowledge through repetition” (Wiedenbeck, Zavala, & Nawyn, 2000, p. 365). Wiedenbeck et al. (2000) suggested learners using the hands-on methodology might neglect to prepare properly in order to benefit from hands-on activities. Warner (2006) identified hands-on activities as a classroom component that increases involvement in actively studying course objectives. After learners have an initial exposure to a hands-on learning event, further knowledge may occur through reflection.

Thoughtful reflection is a process of developing knowledge after the event has occurred. People who engage in thoughtful reflection will observe a process and will look for similarities in other processes where outcomes are consistent. Gerhardt (2006) identified reflection as a necessary activity for curriculum that “contains many contradictions” (p. B20).

Contradictions are gray areas that lack consistently clear outcomes. Faculty emphasize that business education students must understand how to manage environmental contradictions to successfully operate a business in a dynamic and changing environment. Business education instructors use real world contradictions to
challenge students to reflect “in terms of their own experiences, to confront new ideas with old beliefs” (Gosling & Mintzberg, 2004, p. 22). In the context of developing curriculum that embeds contradictions, students develop the skills to make difficult decisions. Difficulty in making decisions when available knowledge is limited suggests that theories may provide an option to develop new knowledge.

In abstract conceptualization, learners use the body of known theories to create understanding. Hauer et al. (2005) determined that for five allied health professions, abstract conceptualization were appropriate when using “logic and ideas to understand problems of situations” (p. 178). Observations revealed that students use the abstract conceptualization learning style, but the small population and findings limit the ability to generalize. Using theories in curriculum, the abstract conceptualization style learners use a set of tested truths or a sequence of events to minimize the potential for errors based on emotions.

Students using active testing learn through employing a reflective style. Engleberg et al. (2001) observed students directly involved in the learning process either as an active participant or as an observer. Reflective style learners utilize deductive assumptions to make sense of the learning event. Technology and learning styles are inseparable when the desired outcome is knowledge acquisition.

Technology has the potential to be a catalyst for developing an interactive learning environment by using simulations, competitions, and role-playing as reported by community college faculty (Quick & Davies, 1999). Instructors incorporate various technologies including visual images, audio files, text-based articles, hyperlinks, and activities to reinforce patterning and inductive learning processes to address the needs of different learning styles (Beyth-Marom et al., 2005; Lui, Wang, Liang, Ko, & Yang,
Researchers using students in sixth-grade classes in Taipei demonstrated that technology increased the ability to deliver individual and collaborative group learning activities (Lui et al.). A benefit for expanding the use of technology in the classroom includes the ability to address the need to deliver curriculum to learners that have a wider variety of learning styles. In a two-year study in the United Kingdom, educators adopted technology with increasing frequency and realized the ability of these technologies to have a positive influence on a student’s desire to learn and engage in class activities. The technologies adaptation to a “variety of learning styles” (Glover & Miller, 2003, p. 20 prompted these positive behaviors.

Distance education environments offer increased access to educational opportunities for students in the delivery of educational content. Distance education students depend on a different set of learning styles, as there is less dependence on synchronous instruction (Menchaca & Bekele, 2008). In a study comparing distance education to traditional classroom students, differences in student attitude for “preferences regarding the mode of tutorial” (Beyth-Marom et al., 2005, p. 249) focused on the need for collaboration versus independence for the distant student. In controlling for variability in the delivery of content, the researchers determined that as instructors or facilitators become more efficient at utilizing classroom time, there were more opportunities to assess student progress on important competencies. Reflection on student progress and pedagogy may identify which learning opportunities seem to have a relationship to student cognition. Providing instructors create a more flexible means of accessing information as part of the learning environment, learners potentially can select the delivery of information that best suits their learning style.
Learning Styles Index and Questionnaire

Much of the work done to understand learning styles has come from the work of Felder and Silverman (1988) in the development of the Index of Learning Styles, and from Kolb’s (1984) research, which resulted in the Learning Style Inventory. Honey and Mumford (1992) developed a self-reporting questionnaire to determine a person’s preference for a learning style and measured success relative to a corresponding match for the available learning style delivered in the learning environment (Charlesworth, 2008). In another study, Zwanenberg, Wilkinson & Anderson (2000) questioned the internal validity of Felder’s and Silverman’s Index of Learning Styles and Honey and Mumford’s Learning Style Questionnaire.

These researchers concluded that the application to populations other than engineering students was not advisable. Generalizing beyond engineering students presents a problem for developing curriculum and measuring the degree to which the curriculum matches the needs of the students for different learning styles. If the curriculum does not match the students’ needs, the perceived benefits of delivering a curriculum through a whiteboard system are more likely to be a product of other instructional variables.

Matching Learning Styles

In a study of 73 post-graduate students, Ford and Chen (2001) found further evidence that presenting a curriculum so it matched the learning style needs of the field-independent and field-dependent learners lead to better academic performance. Another study of 150 remedial writing students tested students to determine their preferred learning style before the presentation of material. The purpose of the testing was to match the student’s learning style (Rochford, 2004).
The results had a positive correlation for knowledge acquisition (Rochford, 2004). In the same manner, an attempt to offer economic students curriculum with multiple, varied learning styles suggests technologically delivered curriculum must incorporate a variety of learning activities. As an intervening variable that is independent to cognition and dependent to the instructional pedagogy, technology may have a strong effect on providing a broad range of activities related to a variety of learning strategies.

Technology

Technology in the Learning Environment

Technology as part of the learning environment is a recent phenomenon of the last three decades (Menchaca & Bekele, 2008). Using computers to deliver instruction, known as computer-aided instruction (CAI), instructors faced many hurdles in the late 1980s, which included access to the technology. By 2002, the computer became a mainstay device as 69% of American households possessed computers, and 59% of American households had home access to the Web (Galuszka, 2005). Ipods, personal digital assistants (PDA), cell phones, digital video recorders, and tablet PCs are devices that students use for making the learning environment more flexible (Galuszka, 2005).

Initially faculty members were concerned about the cost to develop computer-aided instructional programs because effective production software was difficult to obtain for creating “effective pedagogically oriented programs ready to run … on the most popular PCs” (Lovell, 1987, p. 324). By 1994, available computer software programs provided “students with opportunities to personally explore very complex phenomena” (Saiz, 1994, p. 29) of science and cost as little as $100. Within two years, the demand for students trained in how to use technology caused financial strains for many educational
institutions and “represents the greatest threat to integrating computers into administration and teaching” (Roach, 1996, Playing Catch-up section, ¶ 1).

By 2005, the technological revolution was ubiquitous as students and faculty employed a variety of devices to teach curriculum. Students defined instructional technologies to include productivity software used to create presentations, compose word documents, and communicate through e-mail (Peluchette & Rust, 2005), Web search engines (Hinson & Amidu, 2006), web blogs, instant messaging, and hands on activities (Crawford, 2006). These instructional technologies have not transformed the lecture pedagogy as the preferred instructional delivery system indicating that the benefits of instructional technologies are not completely understood (Ganesan, 2007; Talabis, 2007; Tsai, 2007).

As instructors and trainers penetrate the learning environment with technology, the uncertainty of knowing the degree of effectiveness that instructional technologies have on the ability of learners to acquire knowledge still remains (Falvo & Solloway, 2004; Flowers et al., 2000; Muramoto, Campbell, & Salazar, 2003; Palma-Rivas, 2000; Raya & Fernandez, 2002). Kuehn (1991), a telecom analyst of 34 years, observed that “technology is being deployed for its own sake” (p. 93). Education faculty members are still challenged by the struggle to provide a better educational environment that “enhances the learning for our students” (Caverly & MacDonald, 2004, p. 39) and that expands the knowledge needed for new pedagogies.

A classroom that embeds technology into the curriculum can include many types of technology to assist in delivering the desired content. One of the fundamental pieces of equipment is a computer equipped with enough computing power to handle large audio and video files as well as presentation-style software. In the mid 1990s, presentation files
were relatively small compared to multimedia presentations that grew exponentially with the inclusion of audio, video, and animation components.

Removable storage in the 1990s provided instructors portability of presentations up to 1.4 megabytes (MB) in size. Over time as instructors added animations, images, audio, and video components to classroom presentations, and files began to exceed the capacity of the 1.4 MB storage medium. To accommodate the need to handle the growth in file sizes, computers soon came equipped with writable CD drives, which can store files 500 times the 1.4 MB size.

In 2000, IBM introduced an 8 MB flash drive as a portable storage device. Flash drives have grown to exceed 32 gigabytes (GB) in storage capacity. Although file sizes grew with the addition of animations, images, audio, and video components, the monitors remained relatively unchanged except for screen resolution. Monitors with a diagonal screen size of 17 in., although large for a computer system, do not create the same type of learning environment that a large screen projection system creates for a classroom full of students.

Early multimedia projection systems enabled instructors to provide students a much larger visual representation than was possible on a standard computer monitor. In the early 1990s, multimedia projection systems projected the curriculum as a presentation onto a pull-down screen for a class of students to experience while seated at a personal workstation. With new multimedia projection technology, instructors introduced the multimedia presentation as a new pedagogy to facilitate student learning. However, the early multimedia projection systems had poor lighting strength, known as lumens.

Generally, room lighting had to be dimmed or turned off in order for students to be able to read the presentation content (Baker, 2004b). For some students the darkened
room made it difficult to take notes for future reference. For improving the delivery of content through the multimedia projection system, the eventual solution came from the development of whiteboard technologies.

**Whiteboard Technology**

In 2004, the instructional technology allowed the instructor to manipulate the presentation directly from the whiteboard simply by touching a mapped region of whiteboard (Baker, 2004a). By touching specific regions of the mapped whiteboard facilitated by using the software and camera system, instructors could navigate forward and backward through the presentation. Instructors could spontaneously add blank slides for graphs, written instructions, illustrations, or any other type of content necessary to communicate the desired message. Instructors or facilitators could open productivity software like spreadsheets and word processors simply by touching the whiteboard. Content as seen on the Web that might relate to the curriculum could be hyperlinked and captured for future reference by students wanting to review the material covered, making the real time presentation more interesting to learners (Clyde, 2004; Connolly, 2004).

Although instructional technologies are able to create and deliver multimedia files that address the different learning styles of students, having good supplemental software to develop and enhance multimedia files is important. Tegrity has the capability to add audio to presentations, but the file size is often too large to stream without waiting five or more minutes. Reconfiguring and streaming files efficiently can reduce the time to start the software by using supplemental software such as Flash audio files. By 2008, the whiteboard technology known as the Sympodium, a product of SMART Technologies, will bring whiteboard tools to computer monitors and project computer images to a screen (SMART Technologies Incorporated, 2007).
Use of applicable content and the flexibility to forego some of the note taking process makes the presentation more interesting. In the event students ask questions that require further research, a question slide option allows the instructor to record the question and store it at the end of the presentation. Instructors project images onto the whiteboard to share with students, like a photograph, using a pad cam or document camera and then captured into the presentation. Instructors can expand access to information by storing the presentation file on the Web for participants’ future reference. Instructors using the Web for curriculum should take advantage of the ability to offer important interactive components to the content (Chen, Wong & Hsu, 2003).

Current multimedia projection systems, with a 2,000 lumen rating (Baker, 2004b), have sufficient light intensity for students to enjoy standard lighting while curriculum is being delivered. Distributing curriculum material through a multimedia projection system allows instructors to address the needs of students with different learning styles, such as taking notes, hearing explanations, and performing hands on activities that increase a learners’ motivation to develop a stronger understanding of the curriculum (Davies, 1997).

Early projection systems had little functionality other than to enlarge a replicated image of a picture generated on the computer monitor. Today, the available media includes pictures, graphics, videos, audio or sound bits, animations, and interactive programming (Records & Pitt, 2003). Modern technology allows instructors to transform a multimedia presentation into a potential film production.

To create a multimedia presentation, Gaytan and Slate (2002/2003) suggested that four components are necessary, which are as follows: “a computer to coordinate sound, video, and interactivity; links to connect the information; navigational tools that browse
the Web for connected information; and methods to gather, process, and communicate information and ideas” (p. 187). By changing the delivery of course content to a multimedia presentation, instructors can improve the “student’s attention and participation” (Luna & McKenzie, 1997, p. 78) and can reduce the marginal effort for learning new information (Morey, 2001). AL-Bataineh and Brooks (2003) concluded that technology in the classroom and multimedia capabilities moved education to a learner-centered or student-centered environment and away from the traditional teacher-centered environment.

Transforming instruction to a student-centered environment using technology changes the role of both the instructor and the student. With the capabilities to store information as a presentation for delivery in the classroom and with possible Web-assisted resources, instructional technologies improve students’ access to information. Printing presentations as handouts in the form of note pages allows students to engage more actively in discussing and participating in learning the course content rather than take notes.

Instructional technology systems may be set up for all students to have individualized stations or as a centralized system that displays information for all students present to view. In an environment designed for students to engage in multimedia instruction, known as courseware, networking of systems usually occurs, allowing students to learn new skills and to test newly acquired abilities (Ehrmann, 1998). A more recent modality for individualized learning stations depends on an increasing level of technological expertise, and there is evidence that the level of technological experience causes stress for some students (Doutrich, Hoeksel, Wykoff, & Thiele, 2005). Instructors can alleviate student stress with some hands-on work. Networking the system can allow
both instructors and students (Davies, 1997) to view work performed on other computers, creating a learning environment where students benefit and learn from other students’ successes and mistakes.

Advances in technology have allowed instruction to integrate a studio-style format and existing curriculum with little effort. New instructional technologies now capture real time annotations, instructor explanations as audio files, and Web information into the presentation, creating a perceived value that enhances a lecture presentation (Abowd, 1999). Using instructional technology systems known as electronic or interactive whiteboards to deliver classroom presentations or business meetings is a way to encourage audience participation. To reduce the chance of misconstrued information, users can also record documented representations of written communication for future reference (Baker, 2000).

An instructor using a video camera can facilitate the embedment of annotations by taking a picture of the whiteboard and placing that image within the presentation slide. By providing content information in the form of note pages, learners transform participation from note taking, which for many learners is a monotonous, inefficient, and difficult task, to a more participative form of involvement (Abowd, 1999; Lui et al., 2003). At the same time, the facilitator can record in an audio file discussion related to the slide and can embed it automatically into the presentation along with additional real time information from the Web. As more people seek online instruction, instructional technology may be a solution that meets the needs of different learners by embedding appropriate content into the curriculum.

Inclusion of the Web as a part of the delivery system not only provides students and instructors with increased access to curriculum but also provides an opportunity to
promote the development of “higher order” learning opportunities (AL-Bataineh & Brooks, 2003, p. 477). Inclusion of Web-based learning curriculum at Seminole Community College has achieved the desired outcome of producing better-prepared students because the environment promotes active, genuine, and transformative learning (Tremel, 2004). Through the development and delivery of a variety of activities over the Web, students can select a cafeteria-style menu activating the determinants for different learning styles and potentially improving knowledge acquisition. Many universities and colleges are using the resources of a Learning Management System to manage the distance delivery system, (Falvo & Johnson, 2007).

With a Learning Management Systems, the instructor may access a library of content and activities reducing the opportunity cost to develop course content. Learning Management Systems integrate the process of “tracking participation and progress through data systems and assessment” (Falvo & Johnson, 2007, p. 40). This automation potentially improves the ability of the instructor to know when and how to react to difficulties in students’ knowledge acquisition. In a study of 100 institutions of higher education, 79% of the schools used some type of Learning Management System (Falvo & Johnson, 2007).

Using technology, students create personal bonds or relationships that address the need for a stronger learning environment spanning multiple learning styles (Davies, 1997). Although the benefits of an interactive whiteboard include greater audience participation and real time storage of notes (Schweder & Wissick, 2008), the challenge that faces instructors is to create a successful learning environment. Integrating instructional technologies requires the teacher to “merge classroom instruction, relevant on-line instructional techniques, and supplementary materials” (AL-Bataineh & Brooks,
2003, p. 478), a task that may require additional training. Evidence continues to lead instructors toward adopting technology into the curriculum as students show measurable progress in achieving a desired level of competency (Bond, Shipton, Jones, Butler, & Gibbs, 2007).

Technology and Learning

Mayer and Moreno (2003) recommended that “multimedia instruction should be designed in ways that minimize and unnecessary cognitive load” (p. 50). Designing instruction embedded with technology to improve knowledge acquisition presents challenges to the designers that are as complex as the individual’s ability to learn in an ever-changing environment. Nonaka and Nishiguchi (2001) identified organizational culture and technology as essential components for knowledge creation.

Nonaka and Nishiguchi (2001) further recognized knowledge as either tacit or explicit. Tacit knowledge is illusive and difficult to communicate. A general understanding about how organizational processes work and develops comes from the collection of observations and experiences as people work. Explicit knowledge is concrete and recorded as part of the organization’s policy, procedures, and institutional memory and is the easiest knowledge to acquire and, therefore, is not as critical. What makes tacit knowledge unique is that it resides not in a book but in the memories of the organizational members. Both tacit and explicit knowledge are inseparable and “crucial to knowledge creation” (Nonaka & Nishiguchi, p. 14).

Knowledge creation or knowledge management a complex interdisciplinary subject is gaining attention within the field of knowledge studies. Knowledge management includes “business, economics, psychology and information management … and technology in overlapping parts” (Kumar & Thondikulam, 2006, p. 171). Although
knowledge is important, experiential foundations provide learners some of the data necessary to solve complex business problems. How education integrates knowledge across disciplines will determine the success of students. Kumar and Thondikulam predicted that in business, “success of the next generation of knowledge management systems will depend on … the integration of decision-making and actions across inter-enterprise boundaries” (p. 184). Innovation and problem solving skills are essential for the student to develop.

Jordan and Segelod (2006) studied 94 software projects and concluded that projects with “high innovativeness level shows increased personnel knowledge enhancement and retention of proprietary knowledge compared with the low level” (p. 137). An important determinant of success in integrating technology in the process of developing innovative solutions is the effective and efficient ability to share knowledge. Disseminating with technology and managing the flow of information in the sharing process as a collection of pieces of information will determine the extent of knowledge acquisition (Jordan & Segelod, 2006). Using technology instructors can deliver curriculum that includes the use of text, audio, and visual to communicate new knowledge that generally support a set of desired course competencies.

Multimedia instruction fit into one of two general categories of information, static or dynamic. Information that is not dependent on some set of events and that is constant, such as the calculation of income, is static. When information is fluid and outcomes depend on other processes and events, the information is dynamic.

Schär and Zimmermann (2007) determined that a relationship exists between technology and students who control the delivery of course content. They categorized content for the study into “static learning content as facts and concepts … and dynamic
learning content [for] how something interacts” (p. 67). When presented with other content, animations strain cognitive capacity. Animations are learning objects that require an increased level of attention for knowledge acquisition. Unlike static pictures, animations as learning objects create an excessive cognitive load problem that “hinders a possible didactical benefit compared to static pictures” (Schär and Zimmermann, p. 75).

There are many ways to use technology to improve knowledge acquisition. Dissimilar from observing animations, engaging in hands-on activities facilitates the acquisition of knowledge with physical movements. To deliver hands-on activities, traditional classroom instruction by the instructor may use a science lab concept by which students in an exposed environment attempt to perform the desired activity.

Zumbach, Schmitt, Reimann, and Starloff (2006) used a virtual lab and observed that students have a propensity to learn desired concepts in a virtual lab as opposed to a science lab. Zumbach et al. were not able to generalize beyond the study participants the benefits of technology to deliver hands-on learning activities. Additionally, Zumbach et al. other than the study population were not able to establish a relationship between technology and knowledge acquisition. Zumbach et al.’s concern that prior knowledge may affect learning was not an issue because the “learning gain is approximately equal irrespective of the level of prior knowledge” (p. 295).

Some of the new instructional pedagogies incorporate the use of instructional technologies, which includes classroom interactive whiteboards (Clyde, 2004), modularized learning objects (Robson, 2002), on-line applications, programmed learning (Ansalone & Ming, 2006), video, video- and text-based learning objects (Hirumi, 2005), virtual resources (Thornton, 2000), Web-based, and Web/voice applications (F. Wei, Chen, Wang, Li, 2007), computer-aided instruction software (De
Simone, Ives, McWhaw, 2005). Instructors convert the traditional classroom into an interactive monitor for the computer with whiteboard technologies (Solvie, 2004) and can use software to integrate a computer, projection system, camera, and any standard classroom whiteboard. To convert a standard classroom whiteboard requires the use of a computer and camera to map a usable region of the whiteboard for presenting information.

When the instructor interrupts the projection using a hand or pointer at the whiteboard, the presenter can interact with the computer and a number of different processes may be initiated, including advancing the presentation, capturing written annotations in the mapped region, activating hyperlinks to the Web, and overlaying audio, printing, or faxing the presentation to participants. Horton (2000) projected that by 2007, over half of all college students will experience curriculum where technology delivers course content. As a paradigm shift, delivering course content via technology increases the importance of understanding how technology can improve knowledge acquisition.

It may be beneficial for curriculum developers to remember the design of a learning environment is not about using information technology to teach in traditional ways but rather to use technology to support human learning and social interactions. “Technology is viewed not just as a tool for improving the efficiency of traditional instruction based largely on the unidirectional transmission of isolated facts and skills from teacher to students, but as one by which learners actively construct their own knowledge bases and skill set” (Weiqi, Hanwen, Ping, & Ming, 2005, p. 181). Properly utilizing technology for instructional improves knowledge acquisition. The improper use
Conclusion

The literature review identifies the historical research for knowledge acquisition and cognition. Within the body of literature, researchers have identified potential barriers (Assimakopoulos & Yan, 2006; Best, Dockrell, & Braisby, 2006; Schär & Zimmermann, 2007) in developing curriculum that would impede knowledge acquisition. In the proposed study attempting to examine the relationship when students use visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and the acquisition of knowledge, as evidenced by scores on pre- and posttests, it is logical to avoid barriers that may lead to cognitive overload (Schär & Zimmermann, 2007).

Implementation of best practices for didactic environments through course content may assist students to increase knowledge acquisition. Including some of the technologies such as animations (Schär & Zimmermann, 2007) and hands-on activities (Warner, 2006) that have benefited students in other research projects may help to increase knowledge acquisition. Understanding learning styles (Charlesworth, 2008; D. Zhang, 2008; Evans 2008) is another key to developing curriculum that meets the needs of students who are trying to learn new content.

A review of the literature on cognition and learning styles provides an understanding on the different methods that students use to acquire knowledge. Developing technology-based curriculum that allows students to use a preferred learning style may improve knowledge acquisition. Without understanding determinates of the different learning styles, designing appropriate curriculum for knowledge acquisition (Evans, 2008; Warner 2006) may be difficult. By understanding how to use active and
visual learning styles, developers designing curriculum may avoid some of the dilemmas that impede knowledge acquisition. Framed in an environment that addresses learning styles, the proposed research question focuses on understanding if there is a relationship between the use of visual, verbal, or kinesthetic instructional technologies and the score on a recognition test of study material.

Summary

For the proposed study, the purpose will be to evaluate the relationship between embedding new instructional technologies with audio, visual, and kinesthetic instruction and the learners’ cognition relative to the more traditional forms of training or instruction. Evidence shows that students develop cognition in a variety of ways (Gutiérrez-Clellen, Calderón, & Weismer, 2004; Kang, Scharmann, Noh, & Koh, 2005). Students choose different cognitive styles to fit the learning environment. In a broader context, cognitive styles fit into either a field-dependence or a field-independence (Endler, 2000) classification. Differences in cognitive styles relate to the extent learners depend on environmental influences (Tetlock et al., 1993).

Cognition is a function of the propensity for the available learning to take advantage of the strengths of physical senses or an internal need to find associations with personal experiences (Curry et al., 2006; Lee, 2006). Physical sense styles include an active or hands-on and a visual process that utilize a variety of images. Other learning styles search for a logical process based on experiences or a series of interconnected steps that lead to a logical solution. Physical and logical learning styles are part of a fluid combination of learning styles learners select as an adaptation to the learning environment. In every organization, whether it is an educational institution, sole
proprietorship, partnership, or corporation, people have a need to learn new information and businesses are turning to technology to deliver the information.

Whiteboard technology is one such technology that holds promise to deliver information that engages learners and offers the ability to embed a variety of content for different learning styles (Schweder & Wissick, 2008). An important consideration in the use of whiteboard technology by instructors is to consider how students use the system and which component may best aid knowledge acquisition.

An assumption that the study’s literature contains a low proportion of current sources cannot be assessed in the consideration that knowledge and learning has been studied for centuries. More relevant than proportionality is that this study references 133 current articles. Furthermore, a number of foundational studies on this subject continue to have application is the present day. Chapter 3 presents information relative to the methodology, which may assist in the understanding of the relationship between embedding new instructional technologies with audio, visual, and kinesthetic instruction and the learners’ cognition relative to the more traditional forms of training or instruction.
CHAPTER 3: METHOD

The purpose of this proposed quantitative correlational study is to examine the relationship between students use of visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and acquisition of knowledge, as evidenced by scores on pre- and posttests. As part of the study, 130 college students enrolled in the college micro and macroeconomics courses will take a pretest and a posttest. The intent of the proposed study is to expand the body of knowledge for designing curriculum delivered through web based and whiteboard instructional technologies to achieve knowledge acquisition according to expected outcomes.

The method chapter includes a discussion of rationale for using a quantitative correlational design, the appropriateness of the design, the research question, population, geographic location, informed consent, and confidentiality. Additionally, within the method chapter is a discussion on the instrumentation, data collection and analysis, sampling frame, and the validity and reliability of the study.

Research Method and Design Appropriateness

For the proposed study, the method is a quantitative method and the research design is a descriptive and correlational analysis. This study follows statistical designs used to measure the strength of the relationship of the dependent variable to the independent variables (Melnyk & Overholt, 2005). The purpose of correlational analysis is to determine if a relationship exists between the use of visual, verbal, or kinesthetic activities and knowledge recall. Analysis of the correlation between the test scores and the use of visual, verbal, or kinesthetic content files will determine if these content files as part of an instructional technology system has a relationship knowledge acquisition.
Performance of college students for knowledge recall by comparing pre and post-tests for basic college economics is the purpose of the proposed study. The dependent variable is an interval level data element. The TUCE pre and post-test has a point distribution from 0 to 100. The differential scores will provide data to answer the research question. Assuming that the test score distributions approximate a normal distribution determining generalizations on the sample could be made between these two variables.

WebCT Vista 3, the web based instructional technology measures the independent variable accessing the visual, verbal, or kinesthetic curriculum. The visual, verbal, or kinesthetic curriculum within the web site program is identified as a content file. The WebCT Vista 3 program measures the time increments that students access the content pages making the data interval.

For appropriateness of design, the proposed study is designed to determine if a statistically significant correlation exists when students use visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and acquisition of knowledge. The intention of the study is to predict if embedding visual, verbal, or kinesthetic activities has a relationship with knowledge recall. With dependable relationships, businesses may be able to predict the value of purchasing instructional technologies for training and education. Creswell (2005) stated that a correlation exists when there is a relationship between variables where a “pattern for two (or more) variables or two sets of data vary consistently” (p. 325). Correlational analysis will provide evidence of the degree of the relationship between two or more variables (Creswell).
Şımşek (2007) stated that when analyzing quantitative data for pre- and post-test results of fifth grade students for knowledge acquisition, the use of correlational analysis is appropriate. Wasonga (2005) used correlational analysis and a pre and post-test to determine the “effect of multicultural knowledgebase on attitudes and feelings of preparedness to teach children” (p. 67). Schmidt (2007) used correlational analysis and found that students in a Java programming course had a strong relationship between background knowledge and test scores (p. 442). Using a correlational design is an optimal choice to determine whether a statistically significant relationship exists. The correlation design best determines the existence of a relationship among multiple variables such as these (Melnyk & Overholt, 2005).

Research Question

Good decisions on purchasing instructional technologies for knowledge acquisition is difficult when there is little or no data on the relationship between instructional technology and knowledge acquisition. Without information on the relationship between instructional technologies and knowledge acquisition, the decisions to invest in instructional technologies may be an inappropriate use of organizational resources. Ryu et al. (2005) identified specific information that organizational leaders need to make good decisions on the acquisition of instructional technologies. The subsequent question will guide proposed study:

R1. Is there a relationship between the use of visual, verbal, or kinesthetic instructional technologies and the score on a recognition test of study material?

Hypotheses created to support responses to the research questions in terms of alternate (HA) and null (HO) hypothesis will be as follows:
H_{A1}: There is a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material.

H_{O1}: There is not a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material.

H_{A2}: There is a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material.

H_{O2}: There is not a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material.

H_{A3}: There is a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material.

H_{O3}: There is not a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material.

Population

For the fiscal year of 2008-2009, the college population included 6,831 students. For the proposed study, the subset of the population includes 130 students enrolled in the macroeconomics and microeconomics courses. The subset of the population enrolled into the macroeconomics and microeconomics courses should reflect the same demographics of the student population as a whole. The Dean of the Career and Technical has provided the Permission to Use Premises, Names, or Subjects (Appendix A) at Coconino Community College.

Sampling Frame

Students will have the option to either use the instructional technologies or learn by only reading the textbook and attending lectures. For the proposed study, the subset of the total student population is a sample of 130 students, which includes all students.
enrolled in the sections of micro and macroeconomics except the students choosing to opt out of the study. No participant under the age of 18 will be permitted to enter the study. In the scheduled classes, participants will take the TUCE as a pretest before instruction commences. As the study advances, a small percentage of the population may withdraw from the study for various reasons and be unable to complete the experiment.

Informed Consent

Students will have to sign an informed consent letter to participate in the study on the first day of class instruction. A two-stage consent process will be in place whereby, students will first sign in ink the consent form and then participate in the proposed study. Dean of the Career and Technical Division of the college will receive a copy of the letter of informed consent and a description of the purpose of the study. Participation will be voluntary and permission will be acquired from students completing the informed consent: participants 18 years of age and old form (Appendix B). Participants will be able to withdraw from the study at any point during the study without consequences or implications to their course grade. Given that the TUCE tests are not part of the student’s grade, there is no incentive to participate out of concern for losing points toward the calculation of the course grade.

Confidentiality

To ensure confidentiality, the researcher will protect information obtained and generated from participants by altering all personal references and student identification numbers by using a random numerical identifier for each participant. As part of the introductory process the researcher will inform the participants of the study how their data will be utilized. A list of student names will be used to generate a random number associated with each student. The random number provided will be independent of any
personal number or identification. Students use the same number for the pre- and posttest, and the survey. When students finish taking the posttest the list identifying those students and the associated numbers will be cross cut shredded. Any student information that the student puts on the documents will be cut out of the document and cross cut shredded.

Written and electronic data, identifying participant data and informed consent documents will be locked up in a secured cabinet at Coconino Community College for 3 years. After 3 years, all hard copy data will be shredded using a cross cut shredder and all electronic data will be erased from storage devices by reformatting the device. The researcher will not share any data from the proposed study with any third parties. Currently, no third parties are requesting to use the data from the proposed study.

Geographic Location

The proposed study will be limited to students that enroll in a university transferable macro or micro economic course at a community college in Arizona. A transferable course is a class that the university accepts for credit as an equivalent macro or micro economic course. The main campuses of Coconino Community College are located within the city limits of Flagstaff Arizona and on property owned by Northern Arizona University. As a county-based and supported community college, 88% of the students are county residents with the rest being out-of-county, but predominately within Arizona. As reported by the college’s institutional research office the student body’s racial background is as follows: 60% White, 25% Native American, 10% Latino, and 5% African American or Asian American. Most students attend part-time and 12% attend full-time. According to the college’s institutional research office, 54% of the students are under 24 years of age and 57% of students are female.
Instrumentation

The other instruments used are the TUCE pre- and posttest, WebCT Vista 3 instructional technology, and the student survey. As a nationally recognized test for economics, the authors of the test completed extensive testing to ensure the validity of the test. The proposed study will include a subset of questions from the TUCE that relate to the basic concepts for economics.

TUCE Description

William Walstad, Michael Watts, and Ken Rebeck, the Committee on Economic Education of the American Economic Association, and the National Council on Economic Education (NCEE) developed the TUCE assessment through a joint effort (Walstad & Watts, 2005). William Walstad is a professor of economics and Director of the National Center for Research in Economic Education. Michael Watts is a professor of economics, Director of the Purdue Center for Economic Education, and Chair of the Committee on Economic Education of the American Economic Association. Ken Rebeck is an associate professor of economics at St. Cloud State University, and a Research Associate for the National Center for Research in Economic Education.

Appendix C, Permission to use TUCE, includes questions from the Microeconomics pre- and posttest of the Test of Understanding in College Economics 4th edition, a commonly used assessment for economics courses has been received (Arias & Walker, 2004). For the Test of Understanding in College Economics (Appendix D), in the fourth edition, the authors of the test Walstad, Watts, and Rebeck (2006) sequenced the questions uniformly and included variations in complexity to minimize any advantage relative to guessing. Field-tested as a pretest score for more than 6,000 students, the
results indicated that the test was challenging, consistent, and “fairly close to a ‘pure guessing’ level of 25 percent for a four-option multiple-choice test” (Walstad, et al., p. 9).

Troy White, Director of Product Marketing and Sales for the National Council on Economic Education has given permission to use the TUCE. Arias and Walker (2004) used the TUCE to compare student performance and class size. O’Neill (2001) used the TUCE to compare student performance for economics courses that tested with fixed response tests versus economics courses that tested with essay exams. Ziegert (2000) used the TUCE to determine if there was a correlation between personality temperament and learning economics. Ziegert (2000) showed that the TUCE is an appropriate pre- and posttest for measuring knowledge acquisition. Similarly, the proposed research is investigating knowledge acquisition as a response to students’ use of text, audio, or kinesthetic files delivered with instructional technologies, and it is appropriate to use the TUCE pre and posttest.

To test knowledge recall, the TUCE includes 35 multiple-choice questions based on categories of economic content. Of the 35 questions, a subset of 13 questions test the basic concepts of economics that instructors teach in the micro and macroeconomics courses during the first six weeks of the semester. The TUCE questions include scarcity, opportunity cost, factor markets, tradeoffs, price controls, satisfaction, market failures, and demand and supply concepts for determinates.

Foundational concepts for economics are course objectives for both the university and community college macro and microeconomic courses. As part of the articulation process for course transfer between state universities and community colleges, foundational concepts are required to prepare students for upper division curriculum. The TUCE’s purpose is to measure student recall for college introductory economic concepts
in controlled experiments and provides comparative data on student recall at other universities and colleges (Saunders, 1991; Walstad et al., 2006).

**TUCE Reliability and Validity**

Walstad et al. (2006), the authors of the TUCE, evaluated the test for content and construct to ensure the validity and reliability of the instrument. A panel of “distinguished economists and changes were made based on their recommendations” (Walstad et al., p. 18) reviewed the test items for content validity. According to the test developers, there is “substantial evidence from the student sample” (p. 19). Based on test scores of the 5,480 students for the posttest, an improvement of 36% indicated that differences in the pre- and posttest scores had a “probability less than .0001” (Walstad et al., p. 19) that the improvement is a function of chance.

Walstad et al. (2006) measured the reliability of the TUCE, which produced a coefficient alpha of .80 for the Microeconomics version of the TUCE test that will be used for the proposed study. Reliability measured as a correlation coefficient has a range of -1.00 to 1.00. For an instrument or test to achieve reliability, it will generally be in the “.80 to .90 range” (Salkind, 2003). Different factors influence reliability including “whether the test as a whole (or individual questions) is appropriate for the testing of his or her students” (Walstad et al., p. 18). Each of the questions used in the test for assessing knowledge recall of basic economic concepts is consistent with the instructor’s obligation to teach certain course competencies.

**WebCT Vista 3 Reliability**

During the six weeks of instruction that focuses on basic economic concepts, students will read the college approved textbook, complete homework assignments, and attend lectures. WebCT Vista 3 instructional technology system provides additional
resources that include visual, verbal, or kinesthetic files for economic students. Randomly selected economic students will use visual, verbal, or kinesthetic resources.

WebCT Vista 3 automatically measures time increments that each student spends accessing the independent variables of visual, verbal, or kinesthetic activities. For each of the six chapters that cover basic economic concepts, the WebCT Vista 3 system allows students to supplement their learning with an annotated presentation with an audio explanation. Organized by textbook chapters the WebCT Vista 3 system contains hands on activities that include matching terms to definitions by typing the answer into a blank space called filling in the blank or dragging and dropping the term to a designated place. Within WebCT Vista 3, there are 42 activity files for the six chapters. Each file contains on average six recall activities that include matching vocabulary in a multiple choice format and problem solving calculations with and without multiple choice.

WebCT Vista 3 system records the time increments separately for activities devoted to email, threaded discussions, test assessments, or any other non-content related activity. All of the visual, verbal, or kinesthetic activities are located in specific locations called content modules. WebCT Vista 3 system has an automatic log off function for inactivity that partially controls for time not spent on the visual, verbal, or kinesthetic activities by logging students off the system after a period of inactivity on the web site. After the instructor has delivered to the students the curriculum for the fundamental concepts of economic principles common to college micro and macroeconomic courses, the course instructor will administer and collect the posttest.

Student Survey Instrument

To collect the independent variables for age, gender, minority status, technological experience, and major status a student survey will be used. The student
survey is an appropriate tool to collect student self reported demographic information, which are not accessible as part of the student’s college record. The participating student will fill out the student survey after filling out the consent form.

Data Collection

After students receive the introductory letter on the proposed research study (Appendix E) the verbal script (Appendix F) about the study will be read. Following the verbal script, the signed consent forms are collected. On the first day of instruction, the economics instructor administers and collects the TUCE pretest and the student survey (Appendix D).

Participants will be administered the test prior to the first lecture. Students will code the test with a student identification number that the instructor provides. Tests scores are interval and range from 0 to 100, which can be used by SPSS for correlation analysis for determining the extent that instructional technologies have a relationship to knowledge acquisition. Each class will receive a different set of numbers to use so that no two students have the same number. During the 6 weeks following the pretest, students in the college economics course will receive instruction on the basic economic concepts from the course instructor.

The quantitative method analyzes data that are numeric (Creswell, 2005). The qualitative method uses data that is non-numeric and consists of words or text (Creswell, p.39). The mixed method combines a quantitative method and a qualitative method to describe the causal relationship of what is occurring. The numeric data from the TUCE test scores, demographics, and usage of instructional technology are best treated as a quantitative study.
Students will use the same numerical identification assigned at the beginning of the semester for collected and recorded data. Each instructor will print a report in a spreadsheet format that shows the time that each student spent on the visual, verbal, or kinesthetic activities. To protect student identities students will use numerical identifiers for the pre and posttests in place of their name.

Data Analysis

For the proposed study, Statistical Package for the Social Sciences (SPSS) version 18.0 software for Windows will be used for all data analysis. SPSS is a statistical program that is capable generating tables, charts, graphs, descriptive statistics, correlations, and handling missing data. Creswell (2005) identified that “using SPSS, the researcher can have the computer program substitute a value for each missing score” (p. 181).

Researchers often record descriptive statistics to help better understand the data. Descriptive statistics, also referred to as measures of central tendency, “give the researcher a convenient way of describing a set of data with a single number” (Gay, 1987, p.344). Using the mean or average is a number for all data that describes a value for the data set that removes all variation. Gay (1987) describes the mean as the “preferred measure of central tendency” (p. 347).

For the proposed study, SPSS will be used to determine the descriptive statistics. As a convenience, the measures of central tendency reduce complexity of large data sets to numbers that are easily understood. The correlation analysis provides the reader about how independent and dependent data sets move in a related or unrelated manner. Gay (1987) indentifies correlational studies as the collection of data to “determine whether and to what degree, a relationship exists between two or more variables” (p. 354).
A discussion of descriptive statistics for range, mode, mean, standard deviation, and cross tabulation will begin to frame the data set for analysis. The central tendency for a subset of the population using the mode is appropriate to describe nominal data such as gender, and the mean for interval or ratio data such as the TUCE pre and post-test (Gay, 1987). For the subset of the population the use of the standard deviation and range are appropriate for illustrating dispersion. The range provides a “quick, rough estimate of variability” (Gay, 1987, p. 348).

The standard deviation is appropriate for illustrating variability for interval data. The cross tabulation is useful for examining independent variables that are nominally scaled. Using frequency tables for multiple independent variables a cross tabulation will be constructed to examine the distribution of the cases of the independent variables to the dependent variable.

To determine the existence of outliers, the data will be graphed using scatter plots. The use of these graphs is an easy process to identify data that is an “extremely atypical point located at a relatively long distance – an outlying distance – from the rest of the coordinate points” (R. Cohen & Swerdlik, 2005, p. 119). To protect against the possibility of missing outliers, SPSS will be used to check for independent variables that have high levels of influence associated with the existence of outliers. Since the release of SPSS Statistics 14.0 the software program has included the option for “anomaly detection for multivariate outliers” (SPSS, 2008, p. 7).

For the proposed study, SPSS will be used for data analysis. The existence of outliers may indicate students that did not understand the instructions or have “some deficiency in testing” (R. Cohen & Swerdlik, 2005, p. 119). Any presence of outliers will be noted and removed from the data set.
The purpose of this proposed correlational study is to measure the strength of the relationship between the independent and dependent variables to determine effectiveness that instructional technologies with visual, verbal, or kinesthetic files with knowledge recall. In the proposed study, the independent variables are age, gender, minority status, educational major status as business or non-business, technological experience, and as separate activities the visual, verbal, or kinesthetic activities. The dependent variables are the pre and post-test scores for the TUCE. Appendix H identifies the research participant’s values for the independent variables of age, gender, minority status, educational major status as business or non-business, technological experience, and the use of the visual, verbal, or kinesthetic activities.

Karl Pearson’s Product-Moment Correlation Coefficient will be used to assess the relationship between the visual, verbal, or kinesthetic activities and the test scores for knowledge recall. Depending on the analysis of the statistical results including consideration of the level of significance, the null hypothesis will fail to be rejected or be rejected for each independent variable.

*Pearson’s Product-Moment Correlation Coefficient*

Karl Pearson completed the statistical measure for the coefficient of correlation in 1895 as an “illustration of the nature of his statistical biology” (MacKenzie, 1979, p. 140). Pearson’s product-moment correlation coefficient (r) will be used to analyze hypotheses 1, 2, 3, 4, 5, and 6 in order to examine the data for a relationship between student test scores and the use of the learning activities delivered by the instructional technology. Web CT version 3 measures the independent variables for use of visual, verbal, or kinesthetic activities in incremental units of time. Variables that are “measured on a scale of equal units” (Stellefson, Hanik, Chaney & Chaney, 2008, p. 12) can use the
Pearson’s product-moment correlation coefficient (r) to analyze the data. The formula that will be used for a the subset of the population is

\[
r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}}
\]

with \( n \) = sample size, \( x \) = use of visual, verbal, or kinesthetic variable, and \( y \) = test scores. For the \( x \) and \( y \) variables the data pairs should have a “bivariate normal distribution” (Brase & Brase, 2006, p. 589).

Stellefson et al. (2008) noted that using the “multiple R2” (p.13) is an appropriate measure to determine the possibility of a relationship between a dependent variable with multiple independent variables. Appendix I illustrates the correlation table of results for the independent variables of age, gender, minority status, educational major status as business or non-business, technological experience, and visual, verbal, or kinesthetic activities. An \( R^2 \) measure determines the strength of the relationship to the extent that the measure approaches -1.0 or 1.0 (Lind, Mason, & Marchal, 2000). Reynolds, Livingston, and Willson (2006) state that the measure identifies the direction of the relationship as either direct or indirect and that a moderate correlation measures “0.30-0.70” (p.49) and strong correlation measured greater than 0.70.

While there is no clear delineation for significance of the correlation coefficient measures using these measures, “this approach is satisfactory in many situations” (Reynolds et al. 2006, p.49). Gutierrez-Clellen, Calderon, and Weismer (2004) used the Pearson’s product-moment correlation coefficient (r) to compare test results for bilingual children with and without limited English proficiency and verbal working memory. Cholowski and Chan (2004) investigated the problem-solving skills of nursing students and cognitive factors such as “prior knowledge, quality of diagnostic reasoning, and the
quantity and comprehension of nursing diagnosis” (p.85). J. Yang, Yu, Lin, and Hsu (2004) used Pearson’s product-moment correllational analysis to measure the relationship between “basic computer competence of public health nurses in Taiwan and explore factors influencing computer competence” (p. 1).

Correlation Coefficient Interpretation

After the computation of the Pearson product-moment correlation coefficient (r), the value will be interpreted for significance. The subset of the population for the proposed study may have greater value if the estimates of dependency are also applicable to the population. Since there is some margin of error when using a subset of the population statistic “owing to random allocation” (Altman & Bland, 2004, p. 1016) for a population, a level of significance is chosen for the proposed study. The level of significance adjusts the estimates of statistical value to have reliability within the chosen level of significance.

Brase and Brase (2006) suggest that levels of significance are generally of three values, 0.90, 0.95, and 0.99 meaning that the associated percentage of statistical values lies within the “standard normal curve” (p. 401). Use of a 0.90 level of significance is occasionally used for “exploratory studies” (p.384). A number of other studies (Best et al., 2006; Cheng, 2003; McDonald, Zeger, & Kolars, 2008) used confidence intervals of 0.95 when investigating knowledge acquisition.

The proposed study will include a 0.95 level of significance as recommended (Gay, 1987) for being an appropriate confidence interval for most research. By selecting a 0.95 level of significance, there is a 5% chance of making a Type I error where the researcher rejects the null hypothesis that is “really true” (Gay, 1987, p. 384). The problem with selecting a higher level of significance such as 0.99 is that the probability
of committing a Type II error increases. The Type II error occurs when the “researcher fails to reject the null hypothesis that is really false” (Guy, 1987, p. 384).

Pearson’s $r$ value at a 95% confidence interval will be compared to the values in the Critical Values Table for Correlation Coefficient to determine if a significant relationship exists. This value will provide a value for the “maximal margin of error” (Brase & Brase, 2006, p. 404) for the sample distribution. With a 95% confidence interval, it can be said the researcher is 95% confident that the correlation coefficient lies between the computed values. A common symbol for probability level is $\alpha$, and Gay (1987) identified that for “most studies, $\alpha = .05$ is a reasonable probability level” (p.386). For behavioral research “$\alpha = .05$ criterion is widely used as a standard” (J. Cohen, Cohen, West & Aiken, 2003, p. 15). If statistically significant relationships with the dependent variable are indicated, the next process is to test the hypothesis by constructing a correlational table of all the independent variables with significant ones indicated as such.

**Hypothesis Testing**

For each hypothesis, SPSS will test for a significant relationship and reject the null hypothesis in the event that a significant relationship exists (C. Brase & P. Brase, 2006). Absence of a significant relationship will lead to a failure to reject the null hypothesis conclusion and the discovery that the independent variable does not have a relationship with knowledge recall.

**Validity and Reliability**

Determining the validity and reliability of the study is consistent with determining the validity and reliability of the instrument, the data for test scores, use of the learning activities, and the statistical process. According to Salkind (2003) validity is a function of whether the “test or instrument you are using actually measures what you need to have
measured” (p. 115). The ability of the study to repeat and produce the same results measures the reliability of the study (Salkind, 2003).

**Internal Validity**

Cooper and Schindler (2008) indentified the threats to internal validity as “history, maturation, testing, instrumentation, selection, statistical regression, and experimental mortality” (p. 264). The areas of concern for internal validity are maturation, testing, selection, and statistical regression. To address these internal validity issues Cooper and Schindler stated that “all the threats mentioned to this point are generally, but not always, dealt with adequately in experiments by random assignment” (p. 254). Appendix J shows the two test groups and the students’ associated test scores for the proposed study. Walstad et al. (2006) identified that an option to “conceptualize internal consistency” (p. 17) is to randomly group the test scores into two groups and compare the alpha correlation coefficients.

**External validity**

Cooper and Schindler (2008) stated that external validity “is concerned with the interaction of the experimental treatment with other factors and the resulting impact on the ability to generalize to (and across) times, settings, or persons” (p. 255). Cooper and Schindler identified the threats to external validity as “reactivity of testing on X … interaction of selection and X, … [and] other reactive factors” (p. 255). The threats for external validity include the ability to generalize the population of students enrolled in Microeconomics and Macroeconomics courses with other populations using instructional technologies to improve knowledge acquisition. The other threat to external validity is that the scores for the TUCE pre-and posttest may not be representative of large populations that would be tested for knowledge acquisition. To reduce the external
validity of the testing and learning environment the researcher will make every attempt to create “experimental conditions as similar as possible to conditions under which the results will apply” (Cooper & Schindler, p. 256).

Summary

As a quantitative correlational study, the purpose of the proposed study will be to determine and potentially predict the strength of the relationship between the use of visual, verbal, or kinesthetic activities delivered by an instructional technology system and knowledge recall. The statistical designs to measure the strength of the relationship of the dependent variable to the independent variables (Melnyk & Overholt, 2005) for the proposed study is appropriate. Data for pre- and posttest scores for the Test of Understanding in College Economics (TUCE), a self reported demographics survey, and use of the instructional technology system will be collected for the research participants. Walstad et al. (2006) evaluated the TUCE for content and construct to confirm the validity and reliability of the instrument. A population for the proposed study will include 130 Coconino Community College students that enroll in a university transferable macro or micro economic course.

Students who participate in the study will complete the TUCE pre- and posttest, a demographic survey, and informed consent. SPSS version 18.0 will be used to analyze the data. Data analysis will include descriptive analyses and correlation coefficients to determine whether to reject or fail to reject each hypothesis. SPSS will be used for “anomaly detection for multivariate outliers” (SPSS, 2008, p. 7).

The Pearson product-moment correlation coefficient “multiple R²” (Stellefson et al., 2008, p.13) is an appropriate measure to determine the possibility of a relationship between a dependent variable with multiple independent variables. A 0.95 level of
significance as recommended (Gay, 1987) for being an appropriate confidence interval for most research will be used for the proposed study. To reduce internal validity the proposed study will use the “experiments by random assignment” (Cooper & Schindler, 2008, p. 254). Chapter 4 will present the results of the statistical measures.
CHAPTER 4: PRESENTATION OF ANALYSIS OF DATA

The purpose of this quantitative correlational study is to examine the relationship between student’s use of visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and the acquisition of knowledge, as evidenced by scores on the Test of Understanding in College Economics (TUCE). One hundred thirty students participated by taking the TUCE pretest. Prior to administrating the TUCE posttest period 19 students dropped out of the study, leaving 111 students participating.

Chapter 4 presents an analysis of the relationship between the pre and posttest scores of the TUCE and the independent variables of age, gender, minority status, technological experience, major status, and visual, verbal, or kinesthetic activities. The research question is whether there exists a relationship between the uses of visual, verbal, or kinesthetic instructional technologies and the score on a recognition test of study material. The hypothesis statements direct the study to determine if there is a relationship between the use by economic students of visual, verbal, or kinesthetic learning style activities and knowledge recall. The content and data analysis in chapter 4 includes a discussion on the method of data analysis used to determine the existence of a relationship between the dependant and independent variables, and the results of the data analysis as related to the research question.

Sample Population Demographics

Appendix J illustrates the complete frequency distribution of student demographics for age, gender, minority status, technological experience, and major status. Of the research participants, 70 or 63% were male students and 41 or 37% were female students. The distribution of students in the macro and microeconomics courses is
similar to recent study of student demographics for career and technical education courses at Coconino Community College, where 60% (Office of Institutional Research, 2009) of the students in the macroeconomics and microeconomics courses were male. Sixty six percent of the students were between the age of 19 and 23. The study’s participants demographic for age is in contrast to the Coconino Community College demographics study where 68% (Office of Institutional Research, 2009) of the career and technical education students are over the age of 25. The mean age for a typical student for the subset of the population was 24 with a range of 37 and a standard deviation of 5.57 years. Figure 1 illustrates that the median age for the subset of the population as 22 with a mode of 20 years is an appropriate measure to describe student age.

Figure 1

*Age Distribution of Study Population*

Minority students represented 30% of the study population compared to the proportion of minority students for all career and technical education students (Office of Institutional Research, 2009) at Coconino Community College where 35% are non-white.
Of the subset of the population, 49% were business and 51% were non-business. Three quarters of the study population have experience with instructional technology.

The typical student for the subset of the population was a non-business white male student with some instructional technology experience with an age of 23. The typical participant in the study is younger compared to the typical Coconino Community College career and technical education student that is a white male over 25 years of age. Further analysis using SPSS version 18 will provide further insight into the study population.

Data Analysis Procedures

Frequency distributions for the range, mode, mean, standard deviation, and cross tabulation of the independent variables assists in making “data easier to understand by describing trends, averages, and variations” (Larsen & Farber, 2006, p. 33). to describe nominal data such as age, minority status, gender, experience with instructional technology, and major status the mean for interval or ratio data such as the TUCE pre and post-test (Gay, 1987). Table 2 illustrates the codebook used to code data for SPSS version 18. For the subset of the population the use of the standard deviation and range are appropriate for illustrating dispersion. Observations that are “more than two standard deviations from the mean” (Larson & Farber, 2006, p.88) is an additional measure used to identify outliers. The range provides a “quick, rough estimate of variability” (Gay, 1987, p. 348).
Table 2

*Codebook for Student Survey*

<table>
<thead>
<tr>
<th></th>
<th>Coded (0)</th>
<th>Coded (1)</th>
<th>Coded (2)</th>
<th>Coded (3)</th>
<th>Coded (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 Technological Experience</td>
<td>Has not used</td>
<td>Has used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2 Number of classes</td>
<td>0</td>
<td>1-3</td>
<td>4-6</td>
<td>7-9</td>
<td>≥10</td>
</tr>
<tr>
<td>Q3 Major Status</td>
<td>Non Business</td>
<td>Business</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4 Age</td>
<td>18-24</td>
<td>25-31</td>
<td>32-38</td>
<td>39-46</td>
<td></td>
</tr>
<tr>
<td>Q5 Gender</td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q6 Minority Status</td>
<td>White</td>
<td>Non-white</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the proposed study, SPSS version 18 was used to determine the descriptive statistics. Range, mode, mean, standard deviation, and cross tabulation are the descriptive statistics used for the initial analysis. Frequency tables for multiple independent variables and a cross tabulation was created to examine the distribution of the research participant’s independent variables to the dependent variable. For the subset of the population, the standard deviation and range were calculated to illustrate dispersion. To determine the existence of outliers, the data was graphed using scatter plots. To detect the possibility of missing outliers, SPSS version 18 was used to check for independent variables that have high levels of influence using the “anomaly detection for multivariate outliers” (SPSS, 2008, p. 7). Karl Pearson’s Product-Moment Correlation Coefficient was used to measure the strength of the relationship between the visual, verbal, or kinesthetic activities and the test scores in the recall of knowledge. The proposed study included a 0.95 level of significance as an appropriate confidence interval.
Findings

The cross tabulation for verbal instructional technology and TUCE differential test score indicated that those students that used the verbal instructional technology, had differential test scores as measured by a positive gain from the pretest to the posttest. Table 3 generated by SPSS version 18 illustrates of the 69 students in the group that did not participate in using the verbal instructional technology, 38 students or 55% had a positive differential. For the students that participated in using the verbal instructional technology 25 of 42 students or 60% had a positive TUCE differential score.

Table 3

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not use</td>
<td>1</td>
<td>8</td>
<td>13</td>
<td>9</td>
<td>12</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>69</td>
</tr>
<tr>
<td>Used</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

The cross tabulation for visual instructional technology, and TUCE differential had similar results. Table 4 illustrates 53% or 37 of 70 students who did not use the visual instructional technology had a positive differential score on the TUCE. For the students that participated in the visual instructional technology 26 of 41 students or 63% had a positive TUCE differential score.
Table 4

*Visual Instructional Technology and TUCE Differential Score*

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not use</td>
<td>2</td>
<td>9</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>Used</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

Of the students that did not use the kinesthetic instructional technology, 50% or 32 of 64 students had a positive TUCE differential score. Table 5 illustrates 66% or 31 of 47 students who used the kinesthetic instructional technology had a positive TUCE differential score. A comparison of all three instructional technologies shows similar results.

Table 5

*Kinesthetic Instructional Technology and TUCE Differential Score*

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not use</td>
<td>2</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>Used</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

Students who had a positive TUCE differential score and used visual, verbal, or kinesthetic instructional technologies ranged from 60% to 66%, while those who did use any of the instructional technologies ranged from 50% to 55%. Table 6 illustrates a summary of students, who used either verbal, visual or kinesthetic instructional technologies had 5% to 16% more students score better on the posttest than the pretest.
Sixty three percent of the students, who used visual, verbal, or kinesthetic instructional technologies gained points, while only 53% of the students, who did not use any instructional technologies gained points.

Table 6

Summary of Percentage of Participants with

Differential Increases (Pre- to Posttest) TUCE Scores

<table>
<thead>
<tr>
<th>Used</th>
<th>Not used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td>60%</td>
</tr>
<tr>
<td>Visual</td>
<td>63%</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>66%</td>
</tr>
<tr>
<td>Total</td>
<td>63%</td>
</tr>
</tbody>
</table>

Table 7 illustrates a cross tabulation distribution of students with technological experience and the TUCE differential score. Technological experience is familiarity with the instructional technologies used to deliver course content. Instructional technologies include classroom interactive whiteboards (Clyde, 2004), on-line applications, programmed learning (Ansalone & Ming, 2006), video, video- and text-based learning objects (Hirumi, 2005), Web-based, and Web/voice applications (F. Wei, Chen, Wang, & Li, 2007). Technological experience was measured as having used instructional technologies to the student survey, which would include WebCT, Smart board, or Tegrity. Technological experience for TUCE differential did not appear to have a positive relationship as only 55% who did have experience with instructional technologies had a positive TUCE differential score. For students without technological experience 63% had a positive TUCE differential score.
Table 7

*Technological Experience and TUCE Differential Score*

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No experience</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>Experience</td>
<td>2</td>
<td>6</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>13</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>84</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

Table 8 illustrates the cross tabulation results for the number of instructional technology courses that students with technological experience have taken and the TUCE differential score. Of the 84 students with instructional technology experience, 11 students reported having no experience with instructional technology classes. Students having more than five classes using instructional experience generally had a decrease or no change in the differential TUCE score with only 38% having a positive TUCE differential score. For students having 1-3 classes 67% experienced a positive TUCE differential score.
Table 8

Number of Instructional Courses and TUCE Differential Score

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 instructional courses</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>1-3</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>12</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>52</td>
</tr>
<tr>
<td>4-6</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>7-9</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>≥10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>9</td>
<td>15</td>
<td>13</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>91</td>
</tr>
</tbody>
</table>

Table 9 illustrates the cross tabulation distribution of major status and TUCE differential score. Of the 57 non-business majors, 63% had a positive TUCE differential score. Business majors only had 50% of the students achieving a positive TUCE differential score.

Table 9

Major Status and TUCE Differential Score

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-business major</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>12</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>57</td>
</tr>
<tr>
<td>Business major</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>54</td>
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<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

Table 10 illustrates the cross tabulation results of gender and the TUCE differential score. Of the 54 female student 46% of had a positive TUCE differential. Of the 70 male students, 54% had a positive TUCE differential score.
Table 10

Gender and TUCE Differential Score

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2</td>
<td>7</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>11</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>111</td>
</tr>
</tbody>
</table>

Table 11 illustrates the cross tabulation results of minority status against the TUCE differential score. The independent variable for minority status showed that 60% whites had a positive TUCE differential score, with a majority of 52% of non-white students having a positive TUCE differential score.

Table 11

Minority Status and TUCE Differential Score

<table>
<thead>
<tr>
<th>TUCE Differential Score</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>1</td>
<td>5</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>77</td>
</tr>
<tr>
<td>Non-white</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>10</td>
<td>18</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>110</td>
</tr>
</tbody>
</table>

The range for reliability when measured as a correlation coefficient is between -1.00 and 1.00. When the reliability measure is in “.80 to .90 range” (Salkind, 2003) the instrument is considered reliable. The reliability of the TUCE as measured by Walstad et al. (2006) produced a coefficient alpha of .80 for the Microeconomics version of the TUCE test. The questions on the TUCE assess the basic economic concepts that are
consistent with the course competencies that address the concern for “whether the test as a whole (or individual questions) is appropriate” (Walstad et al., p. 18).

The research question for the study was to determine if there a relationship between the use of visual, verbal or kinesthetic instructional technologies and the score on a recognition test of study material. The $H_{A1}$ hypothesis is to determine if the use of visual instructional technologies and the score on a recognition test of study material. Table 12 illustrates the results of the bivariate 1-tailed Pearson product-moment correlation analysis using SPSS version 18 for instructional technologies and the differential TUCE score. A 1-tailed test was used because of the supposition regarding a positive relationship for students who used instructional technologies and the differential TUCE score. The TUCE differential score is the differential increase in the pre – to posttest TUCE scores.

To determine the existence of a relationship SPSS version 18 generated a bivariate 1-tailed Pearson product-moment correlation coefficient ($r$) measure of .089. Since the correlation measure is not at least .30 the $H_{A1}$ hypothesis is rejected. At an $\alpha = .05$ level of significance, where there is a 95% level of confidence the measure would need to have been at least a .30 to reject the $H_{O1}$ hypothesis. Since the significance measure for the 1-tailed test (Sig.1) of .176 is more than .05 not rejecting the $H_{O1}$ is validated. The $H_{O1}$ hypothesis for this study was that there is not a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material. The $H_{O1}$ hypothesis was not rejected when the SPSS version 18 analysis for the Pearson product-moment correlation coefficient ($r$) using a bivariate 1-tailed test returned a measure of .089. The result of the SPSS version correlation coefficient
measure indicates a lack of evidence for a relationship between the use of visual instructional technologies and the student’s score for the TUCE.

The $H_{A2}$ hypothesis is to determine if the use of verbal instructional technologies and the score on a recognition test of study material. The $H_{A2}$ hypothesis is rejected because the bivariate 1-tailed Pearson product-moment correlation coefficient ($r$) measure (See Appendix I) of $.055$ is not at least $.30$. The $H_{O2}$ hypothesis for this study was that there is not a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material. Failure to reject the $H_{O2}$ hypothesis occurred when the SPSS version 18 analysis for the Pearson product-moment correlation coefficient ($r$) using a bivariate 1-tailed test returned a measure of $.055$. The significance measure for the 1-tailed test (Sig.1) of $.284$ is more than $.05$ also validating the failure to reject the $H_{O2}$. The result of the significance measure indicates no relationship between the use of verbal instructional technologies and the student’s score for the TUCE.

The $H_{A3}$ hypothesis is to determine if the use of kinesthetic instructional technologies and the score on a recognition test of study material. The measure from Table 12 for Pearson product-moment correlation coefficient ($r$) is $.106$. The $H_{O3}$ hypothesis for this study was that there is not a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material. The output in Table 12 from SPSS version 18 analysis for the Pearson product-moment correlation coefficient ($r$) using a bivariate 1-tailed test returned a measure of $.16$ indicates a failure to reject the $H_{O3}$ hypothesis. The significance measure for the 1-tailed test (Sig.1) of $.047$ is less than $.05$ indicates a level of significance and the $H_{O3}$ would be rejected. While the significance measure indicates that the $H_{A3}$ is significant with the Pearson correlation product-moment coefficient of $.16$ any relationship would be weak.
Analysis of the other independent variables for a relationship with the differential TUCE score indicates there is no significant relationship based on the Pearson product-moment correlation coefficient ($r$). The measure from Table 12 for the independent variables of age is .054. The correlation coefficient measure of .054 indicates no relationship to the TUCE differential score. The measure of significance at .288 also indicates at a .05 level of significance the absence of a significant relationship between age and the differential TUCE score.

The Pearson correlation coefficient for the independent variable, technological experience is -.067. The significance measure from Table 12 for technological experience is .242. Both of the Pearson correlation coefficient and the significance measures indicate the lack of a significant relationship between technological experience and the differential TUCE score.

For the independent variable number of instructional technology courses the measure from Table 12 is -.253. This indicates the absence of a significant relationship between the number of instructional technology courses and the differential TUCE score. The significance measure is .008, which at a .05 level of significance would indicate a significant relationship, but collectively would appear to be a very weak relationship between the number of instructional technology courses and the differential TUCE score.

Analysis from SPSS version 18 for major status reported a Pearson correlation coefficient of -.147. The significance measure from Table 12 is .062. Both of the Pearson correlation coefficient and the significance measures indicate the lack of a significant relationship between major status and the differential TUCE score.

The Pearson correlation coefficient for the independent variable, gender is .03. The measure of .03 indicates the lack of a significant relationship between gender and the
differential TUCE score. The .378 measure for significance from Table 12 verifies the absence of a significant relationship between gender and the differential TUCE score.

The Pearson correlation coefficient for the independent variable, minority is -.146. The significance measure from Table 12 for minority is .064. Both the Pearson correlation coefficient and the significance measure indicate a lack of a relationship between minority and the differential TUCE score. The last analysis was to verify the existence of any outliers.

SPSS version 18 was used to test for outliers. SPSS version 18 will not test for outlier unless all data elements have a value. One observation did not include the participant’s age. The missing data element was replaced with the numeric placeholder of 99. SPSS version 18 tested for outliers and reported no outliers in the data set.

Summary

Chapter 4 included data from the student surveys and TUCE scores. As identified in Chapter 3 descriptive statistics described the independent variable data. Using a variety of measures that included the mean, median, mode, standard deviation and cross tabulation the independent variables for age, gender, minority status, technological experience, major status, and visual, verbal, or kinesthetic activities were described and illustrated in tabular form.

Pearson product-moment correlation coefficient (r) analysis using a bivariate 1-tailed test was implemented using the independent variables for age, gender, minority status, technological experience, major status, and visual, verbal, or kinesthetic activities and the dependent variable for the differential TUCE score. The results of the test did not lead to a rejection of the null hypothesis. The problem as stated in chapter 1 was that to
date research has not adequately documented the benefits of using instructional technologies with verbal, visual, and kinesthetic activities.

As illustrated in Table 6, a summary of the cross tabulation between the instructional technologies and the TUCE differential scores, a majority of students had a positive TUCE differential score and used visual, verbal, or kinesthetic instructional technologies, which ranged from 60% to 66%. As a comparison, the students who did use any of the instructional technologies had a lower percentage of students that had a positive TUCE differential score, which ranged from 50% to 55%. A cumulative measure of all students indicated 63% of the students, who used visual, verbal, or kinesthetic instructional technologies gained points, while only 53% of the students, who did not use any instructional technologies gained points.

The results of the study have not statistically determined a relationship between the visual, verbal, or kinesthetic activities and the score on a recognition test of study material. The discussion in Chapter 2 on the complexity relevant to the problem statement is also relevant to instructional technology and knowledge acquisition. Chapter 5 will provide a discussion of the conclusions and recommendations for the study.

All of the hypothesis will be individually discussed in Chapter 5. Recommendations for future studies will be included as a number of students had negative differential TUCE scores that influenced the test results. Chapter 5 will include a conclusion related to the problem and hypothesis statements, which is relevant to the field of leadership.
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

A positive return on investment is an important consideration when leadership makes a decision to invest a business’ assets. Leadership has a fiduciary responsibility to make the best possible use of the business’ assets. Educational leadership invests millions of dollars in instructional technology to improve student learning. Business leadership also invests large capital dollars in instructional technologies for employee training. Leadership’s investment in instructional technology and fulfillment of the fiduciary responsibility to the investor cannot be fully justified when research has yet to determine the quantifiable benefits of instructional technology in the recall of knowledge.

This study was conducted specifically, to assist in determining whether the learning gained justifies the expense of the instructional technology. The purpose of this quantitative correlational study was to examine the relationship between student’s use of visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements and the acquisition of knowledge, as evidenced by scores on the Test of Understanding in College Economics (TUCE). The steps used to answer the research question included defining the independent and dependant variables, collection of data, developing the statistical hypotheses, and calculating Pearson product-moment correlation coefficients ($r$) to assess the relationship between instructional technologies and knowledge recall. Chapter 5 will cover the topics of findings analysis, implications, and recommendations.

Findings and Interpretations

The discussion in chapter 4 focused on indentifying the demographic characteristics in a descriptive statistics section, presentation of data analysis, and summary. The descriptive statistics analysis used the measures averages, medians,
modes, and cross tabulations to provide some understanding of the underlying characteristics of the independent variables. The Pearson product-moment correlation coefficient provided information on the potential relationship between the independent variables for instructional technologies and the dependent variable, which is the score on a recognition test of study material.

**Sample Population Demographics**

The subset of the population was similar to the general community college student population except for only gender. The macro and microeconomics courses reside in the academic business department for the career and technical education division because the courses are required as fundamental courses for the business degree. The demographics for subset of the population showed that the majority of the students were not business students, which indicates that the majority of the macro and microeconomics students are taking the course for other reasons. The 70% male distribution of the subset of the population is unique to either academic division within the college, implying that macro and microeconomics courses are a male dominated discipline. Based on the demographic information it would be difficult to imply that any findings would be relevant to the general student population for the community college.

**Findings**

The discussion on findings in Chapter 4 included cross tabulation and Pearson product-moment correlation coefficient on the relationship between the dependent variables visual instructional technology, verbal instructional technology, kinesthetic instructional technology, age, minority status, gender, experience with instructional technology, major status, and the dependent differential TUCE score variable. The analysis of the cross tabulation yielded some information for the independent variables
that was expected, as prior research (Durham et al., 2007; Gobet, 2005; Schär & Zimmermann, 2007) for cognition and knowledge recall did not indicate the existence of a relationship to the demographic variable for age, minority status, gender, experience with instructional technology, and major status. The cross tabulation for the visual, verbal, and kinesthetic instructional technologies did yield some useful evidence.

From the cross tabulation results, students that used the kinesthetic instructional technology had better results regarding the differential TUCE scores than the students that did not use the instructional technology. Sixty three percent of the students that used the kinesthetic instructional technology had positive differential TUCE score, compared to only 50% of the students that did not use the instructional technology. When looking at the number of students that used the instructional technologies, compared to the number of students that did not use the instructional technologies, it appeared that using the technologies had some benefit to learners. Ten percent more students that used the instructional technology had a positive increase in the differential TUCE score, which does not account for magnitude of the increase in TUCE scores.

Forty-eight students did not improve from their pretest TUCE score. The 48 students earning negative differential test scores make it improbable for finding a statistically significant relationship between the instructional technologies and knowledge recall, when the expectation is that the instructional technology would have a positive effect in the recall of knowledge. The structure of Coconino Community College’s economic instruction focuses on presenting curriculum using multiple pedagogies that influence cognition. Instructors at Coconino Community College deliver curriculum through lectures and different class activities that to different degrees provide visual, verbal, and kinesthetic opportunities for students to learn economic concepts. Students
complete assessments on the previously delivered curriculum understanding that higher assessment scores lead to successful completion of the course.

There may be extraneous factors present during instruction between the pre and post TUCE test that influenced the decline in post-test scores, when the expectation was that the post TUCE scored would increase. One possible factor may be the relatively difficulty of the concepts presented during the instructional period between the pre and posttest. Other factors may be more behavioral, such as the level of student motivation, the level of the student’s academic ability, personal commitments outside of college, time management, and other courses commitments.

The $H_{A3}$ hypothesis is that a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material was the only instructional technology to indicate that a weak relationship may exist. This finding contradicts previous research that suggests that kinesthetic instructional technology does not have a relationship with knowledge recall. Zhu and Baylen (2005) stated “technology itself is insufficient to promote meaningful and quality interaction among learners and with the content materials which will lead to the desired learning outcomes” (p. 266).

The $H_{A1}$ hypothesis is that there is a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material. The Pearson product-moment correlation coefficient analysis revealed that there was no statistically significant relationship between the two variables. The concerns on the time and quality of students using the instructional technology are the same for the visual and verbal instructional technology.

The $H_{A2}$ hypothesis is that there is a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material.
The Pearson product-moment correlation coefficient analysis revealed that there was no statistically significant relationship between the two variables. While not part of the study, a possible variable that may have influenced verbal instructional technologies would be the downloading time to access the activity.

As an exploratory study other factors not originally considered as part of the study may be exposed. One issue that may have influenced the existence of a relationship for the visual and verbal hypotheses is whether the student’s involvement was sufficient with the instructional technology. As an exploratory study, measuring the time and quality of study was not a measurable variable. The Pearson product-moment correlation coefficient included all students regardless of how much time the student used the instructional technology, which could have been only a few minutes. This raises the question about the true effect the instructional technology may have on knowledge recall.

Summary

The cross tabulation analysis showed that students, who used the kinesthetic instructional technology, had more students as a percentage of the subset of the population that had a positive differential TUCE score. The findings of this study indicate a weak relationship for $H_{A3}$ that a significant correlation between the use of kinesthetic instructional technologies and the score on a recognition test of study material. Analysis for both $H_{A1}$ that a significant correlation between the use of visual instructional technologies and the score on a recognition test of study material and $H_{A2}$ that a significant correlation between the use of verbal instructional technologies and the score on a recognition test of study material indicated no statistical significance.

The implication of these results implies that the decision by leadership bases the decision to invest in instructional technologies rests with other factors than knowledge
recall. Previous research (Passerini, 2007; Zhu & Baylen, 2005) has not definitively linked instructional technologies and knowledge recall. The elusiveness of this research topic and the difficulty in identifying the benefits of instructional technology related to knowledge recall needs further research. Until research can identify any link to instructional technology and knowledge recall, leadership may continue to make investment decisions based on the conventional thinking that instructional technology is beneficial.

Recommendations

The field of knowledge acquisition and cognition has spanned centuries of investigation that has yet to develop a complete understanding of these disciplines. The literature review in chapter 2 just barely covers what people know about cognition and knowledge acquisition. This study investigates only a small element of knowledge acquisition or cognition.

When leaders make a decision to invest in instructional technologies the knowledge that the investment may not have a relationship to knowledge recall may be sufficient to justify the allocating resources to other activities. If the intent for investing is to develop and delivery kinesthetic instructional technologies some benefit to knowledge recall may occur, but leaders should be cautious with this type of investment. When faculty or other organizational groups request or suggest expenditures for instructional technologies, leaders should identify that just making visual, verbal, or kinesthetic instructional technologies available will not by themselves improve knowledge recall. Before leaders invest in instructional technologies alternative investment and training in developing an instructional delivery methods that employs the cone of learning where Thomas Lord (2007) determined that the “cooperative learning group [and the] teaching
another” (p. 15) method of teaching had a positive influence on knowledge recall should be considered.

Suggestions for Further Research

Leadership needs future research to answer the question about the benefits between instructional technologies and knowledge recall; otherwise, leadership will continue to use conventional thinking concerning the investment in instructional technologies. Future research may want to consider that a student’s time on task may influence knowledge recall. Controlling for this while engaged with the instructional technology may indicate that a statistically significant relationship exists between the instructional technology and knowledge recall. Assessing student-learning styles and matching the learning styles with the same type of instructional technology may change a student’s motivation to learn information. Motivation by the student to perform better may be induced by providing a reward, which is generally points that count toward the student’s grade. The variance in student abilities may have created barriers that impeded learning. Adding a control group with similar abilities to a research study may yield different results in the recall of knowledge. Future research efforts directed at investigating kinesthetic instructional technologies and the relationship to knowledge recall may be appropriate given the evidence from this study on a weak relationship between kinesthetic instructional technology and knowledge recall combined with Passerini’s (2007) research that suggests the length of the instruction affects “student recall performance” (p. 208).

Summary and Conclusion

This quantitative correlational study investigated the rationale that a relationship exists between instructional technologies and knowledge recall and the decisions that
leaders make to invest organizational resources in instructional technologies. Witkin’s theoretical framework proposed that different cognitive styles make a difference for acquiring knowledge (Witkin, Goodenough, & Karp, 1967). The literature illustrated that students have different learning styles. Literature on instructional technologies confirmed that a gap exists in the knowledge of whether there is a statistically significant relationship between instructional technologies and knowledge recall. Based on the pre and post TUCE results for 111 students only kinesthetic instructional technologies had a weak relationship. Leadership needs to consider the relationship between instructional technologies and knowledge recall when investing organizational resources and this study did not show a strong relationship with any of the instructional technologies.
REFERENCES


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UNIVERSITY OF PHOENIX

PERMISSION TO USE PREMISES, NAME, AND/OR SUBJECTS
(Facility, Organization, University, Institution, or Association)

Coconino Community College

Check any that apply:

☒ I hereby authorize Paul Holbrook, student of University of Phoenix, to use the premises (facility identified below) to conduct a study entitled THE INFLUENCE OF INSTRUCTIONAL TECHNOLOGIES FOR KNOWLEDGE ACQUISITION.

☒ I hereby authorize Paul Holbrook, student of University of Phoenix, to recruit subjects for participation in a conduct a study entitled THE INFLUENCE OF INSTRUCTIONAL TECHNOLOGIES FOR KNOWLEDGE ACQUISITION.

☒ I hereby authorize Paul Holbrook, student of University of Phoenix, to use the name of the facility, organization, university, institution, or association identified above when publishing results from the study entitled THE INFLUENCE OF INSTRUCTIONAL TECHNOLOGIES FOR KNOWLEDGE ACQUISITION.

\[Monica\, Baker\]

Signature

Monica Baker

Name

Dean of Career of Technical Education

Title

Address of Facility 2800 S. Lone Tree Rd.

Flagstaff, AZ 86001

S/12/09

Date
APPENDIX B: INFORMED CONSENT: PARTICIPANTS 18 YEARS OF AGE AND OLDER
UNIVERSITY OF PHOENIX

INFORMED CONSENT: PARTICIPANTS 18 YEARS OF AGE AND OLDER

Dear ____________________________,

I am a student at the University of Phoenix working on a Doctorate of Management in Organizational Leadership. I am conducting a research study entitled The Influence of Instructional Technologies for Knowledge Acquisition. The purpose of the research study is to determine the degree to which using visual, verbal, or kinesthetic instructional technologies as classroom instructional enhancements affects the acquisition of knowledge, as evidenced by scores on pre- and posttests.

Your participation will involve taking a nationally standardized pre- and posttest for understanding college economics at the end of the participation period. With the pretest, there is a short survey of personal demographics to be filled out. Visual, verbal, or kinesthetic activities will be delivered through the instructional technology Web site for your economic class. Each time you use the instructional technology for learning economics the system will measure your activity with the technology. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, you can do so without penalty or loss of benefit to yourself. The results of the research study may be published but your name will not be used and your results will be maintained in confidence. Written and electronic data, identifying participant data and informed consent documents will be locked up in a secured cabinet at Coconino Community College for 3 years. After 3 years, all hard copy data will be shredded using a cross cut shredder and all electronic data will be erased from storage devices by reformatting the device.

In this research, there are no foreseeable risks to you except “none”.

Although there may be no direct benefit to you, the possible benefit of your participation is increased knowledge acquisition of course outcomes for this economics course, and the ability for faculty to develop and deliver more effective course content for knowledge acquisition.

If you have any questions concerning the research study, please call me at (928)226-4248.

Sincerely,

Paul Holbrook
APPENDIX C: PERMISSION TO USE TUCE
Mr. Paul Holbrook  
Address 2343 Elk Run  
Flagstaff, AZ 86004  

Dear Paul,  

Thank you for your request for permission to use Test on Understanding College Economics, 4th ed. in your research study. We are willing to allow you to reproduce the instrument as outlined in your letter at no charge with the following understanding:  

- You will use this survey only for your research study and will not sell or use it with any compensated management/curriculum development activities.  
- You will include the copyright statement on all copies of the instrument.  
- You will send your research study and one copy of reports, articles, and the like that make use of this survey data promptly to our attention.  

If these are acceptable terms and conditions, please indicate so by signing one copy of this letter and returning it to us.  

Best wishes with your study.  

Sincerely,  

[Signature]  

Troy White  
Director of Product Marketing & Sales  
National Council on Economic Education  

I understand these conditions and agree to abide by these terms and conditions.  

[Signature]  

Expected date of completion [ ]

1
APPENDIX D: TEST ON UNDERSTANDING COLLEGE ECONOMICS
Test on Understanding College Economics

Place a check mark in front of the correct answer

1. In an economy where heating oil is the primary source of heat for most households, new supplies of natural gas, a substitute for heating oil, are discovered. Natural gas provides heat at a much lower cost. What is the most likely effect of these discoveries on the market price and quantity of heating oil produced?

<table>
<thead>
<tr>
<th>Price</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ Decrease</td>
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</tr>
<tr>
<td>_____ Decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>_____ Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>_____ No Change</td>
<td>No Change</td>
</tr>
</tbody>
</table>

2. Suppose a city facing a shortage of rental apartments eliminates rent controls. Which of the following is most likely to occur?

| Decrease in rents and a decrease in the number of apartment units supplied |
| An increase in rents and an increase in the number of apartment units supplied |
| A decrease in the demand for apartments and an increase in the number of apartment units supplied |
| An increase in the demand for apartments and a decrease in the number of apartment units supplied |

3. If all of the firms in a competitive industry are legally required to meet new
regulations that increase their costs of production:

______ supply of the product will decrease.
______ demand for the product will decrease.
______ the long-run economic profits of individual firms in the industry will decrease.
______ the short-run economic profits of individual firms in the industry will increase.

4. Which of the following correctly describes an external benefit resulting from an individual's purchase of flu shots from a doctor?

______ Doctors earn income by charging for flu shots.
______ Flu shots are less expensive than catching the flu.
______ Flu shots reduce the likelihood of others catching the flu.
______ Flu shots reduce sick days, allowing those who get flu shots to earn more income.

5. A state legislature increased the tax on gasoline sold in the state from $.20 to $.30 per gallon. A supporter said the tax would "make the distribution of after-tax income in the state more equal." This statement would be true only
if it could be shown that, after the tax is increased:

______ people with low incomes buy more gasoline than people with high incomes.

______ the quantity of gasoline purchased in the state is highly responsive to changes in price.

______ people with high incomes tend to spend the same proportion of their incomes on gasoline as people with low incomes.

______ people with high incomes tend to spend a larger proportion of their incomes on gasoline than people with low incomes.

6. The opportunity cost of being a full-time student at a university instead of working full-time at a job includes all of the following EXCEPT:

______ payments for meals.

______ payments for tuition.

______ payments for books.

______ income from the full-time job.

7. A recent hurricane destroyed half of the orange crop. Consumers are responding to an increase in the price of oranges by buying more apples. This change is expected to increase the price and quantity of apples sold. In terms of basic supply and demand analysis, there has been a:
shift in the demand curve for both oranges and apples.

movement along the demand curve for both oranges and apples.

shift in the demand curve for oranges and a movement along the demand curve for apples.

movement along the demand curve for oranges and a shift in the demand curve for apples.

8. "The effect of an excise tax on the products of pollution-producing industries will be a cutback in production. If the tax was levied directly on the amount of pollution generated, the long-run cutbacks in production would be much smaller." This statement is most likely to be:

false, provided the amount of the taxes on products and pollution is equal.

false, because most firms would rather pay the tax than cut back production.

true, because firms would have a greater incentive to adopt new technology that causes less pollution.

true, because most taxes levied on pollution affect the demand curve; taxes on products affect the supply curve.

9. The market demand for a product has increased if:

the product price has increased.

more of the product is produced.

more of the product can be sold at all possible prices.

the cost of producing the product decreased due to new technology.
10. "Ticket prices for professional team sports are high because the team owners just pass the costs of the athletes' high salaries on to ticket buyers." Is this statement generally correct or incorrect? Why?

______ Correct. High sports salaries contain "economic rent" and economic rent normally gets passed on to consumers.

______ Correct. High sports salaries force owners to charge high ticket prices, which they can pass on to consumers because demand is elastic.

______ Incorrect. High sports salaries contain "economic rent" and would not be so high if the public were unwilling to buy tickets at the high prices.

______ Incorrect. Owners can afford to pay the high salaries without raising ticket prices. They raise prices simply to increase their marginal revenue above their marginal cost.

11. In a country where only two goods are produced and consumed, the production and consumption of Good X results in external benefits, while the production and consumption of Good Y results in external costs. Would unregulated markets produce too much or too little of Good X and Good Y, compared to the efficient output levels for these products?

<table>
<thead>
<tr>
<th>Good X</th>
<th>Good Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Too much</td>
<td>Too much</td>
</tr>
<tr>
<td>Too much</td>
<td>Too little</td>
</tr>
</tbody>
</table>
12. Public goods are generally provided by government rather than private firms because:

- people must pay for public goods if they want to consume them.
- public goods can be used by one person without reducing the amount that is available to others.
- special interest groups get the government to produce public goods, even if the costs of producing them are greater than the benefits.
- it is less expensive for government to produce goods that are most important to consumers because the government does not make profits.

13. The table below shows the tons of rice and corn that can be produced in Country X and Country Y in one year, using the same amount of productive resources.

<table>
<thead>
<tr>
<th></th>
<th>Rice</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country X</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Country Y</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

According to the theory of comparative advantage, what should firms in Country X do?

- export rice to Country Y and import corn
- export corn to Country Y and import rice
______ export both rice and corn to Country Y
______ import both rice and corn from Country Y
Introductory Letter

I, Paul Holbrook, am conducting a research experiment to determine if there is a relationship between the use of visual, verbal, or kinesthetic activities and knowledge recall. Knowledge recall will be measured by the means of a nationally standardized pre- and posttest on understanding college economics. Your participation in this project is voluntary and will last six weeks or less, during which time the college’s Web-based course delivery system, will measure the time increments you use the visual, verbal, or kinesthetic learning activities. The potential risks could be that you use the activities and receive no additional benefit in additional course knowledge. The potential benefits are that students will increase knowledge acquisition for course content.

All records are confidential and student information is recorded as a case numbers. The researcher’s mailing address is 2800 S Lone Tree, Flagstaff, AZ 86001. The researcher’s phone number is 928-226-4248. For further question on the research study and about the rights of research subjects students may contact the Dean of Career and Technical Education Division at Coconino Community College. The phone number is (928) 226-4262.

No student under the age of 18 may participate in this research experiment. Participation in this research is voluntary and students may with draw at any time.
APPENDIX F: VERBAL SCRIPT
Verbal Script

I am conducting a research experiment to determine if there is a relationship between the use of visual, verbal, or kinesthetic activities and knowledge recall. Knowledge recall will be measured by the means of a nationally standardized pre- and posttest on understanding college economics. Your participation in this project is voluntary and will last six weeks or less, during which time the college’s Web-based course delivery system, will measure the time increments you use the visual, verbal, or kinesthetic learning activities. The potential risks could be that you use the activities and receive no additional benefit in additional course knowledge. The potential benefits are that students will increase knowledge acquisition for course content.

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APPENDIX G: STUDENT SURVEY
Student Survey for:

A quantitative study of instructional technologies utilizing visual, verbal, and kinesthetic activities for knowledge acquisition.

Case number: _____________________________

Place an “X” in front of the option that most closely represents you

Technological Experience:

_____ Has NOT used instructional technology before this course (WebCT, Smart board, of Tegrity)

_____ Has used instructional technology before this course (WebCT, Smart board, of Tegrity)

_____ Number of courses completed using instructional technologies

Degree Status:

_____ Is NOT registered as a business major

_____ Is registered as a business major (ABUS, AA HRM, AAS Business Technologies, AAS Hospitality Management, Accounting Tech Certificate

Age: ____________________

Gender:

_____ Male

_____ Female

Minority Status:

_____ White

_____ Native American

_____ Asian
_____ African American

_____ Other
APPENDIX H: PARTICIPANTS VALUES FOR INDEPENDENT VARIABLES
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APPENDIX I: CORRELATION RESULTS FOR INDEPENDENT VARIABLES
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Correlations for Age by Bins, Gender, Minority Status, and Test Score Differential

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APPENDIX J: FREQUENCY DISTRIBUTIONS OF STUDENT DEMOGRAPHICS
### Frequency Distributions of Student Demographics

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