8-2014

The Effects of Narration and Mnemonics Within a Gaming Environment for the Achievement of Conceptual and Procedural Knowledge on Undergraduate Business Students at Indiana University of Pennsylvania

Rajendra Kumar Murthy
Indiana University of Pennsylvania

THE EFFECTS OF NARRATION AND MNEMONICS WITHIN A GAMING ENVIRONMENT FOR THE ACHIEVEMENT OF CONCEPTUAL AND PROCEDURAL KNOWLEDGE ON UNDERGRADUATE BUSINESS STUDENTS AT INDIANA UNIVERSITY OF PENNSYLVANIA

A Dissertation

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Doctor of Philosophy

Rajendra Kumar Murthy

Indiana University of Pennsylvania

August 2014

Indiana University of Pennsylvania
School of Graduate Studies and Research
Department of Communications Media

We hereby approve the dissertation of

Rajendra Kumar Murthy

Candidate for the degree of Doctor of Philosophy

06-17-2014 Signature on file
Luis C. Almeida, Ph.D.
Associate Professor of Communications Media and Instructional Technology, Advisor

06-17-2014 Signature on file
Mark J. Piwinsky, Ph.D.
Professor of Communications Media and Instructional Technology

06-17-2014 Signature on file
Jay Start, Ph.D.
Associate Professor of Communications Media and Instructional Technology

ACCEPTED

Signature on file
Timothy P. Mack, Ph.D.
Dean
School of Graduate Studies and Research

Title: The Effects of Narration and Mnemonics Within a Gaming Environment for the Achievement of Conceptual and Procedural Knowledge on Undergraduate Business Students at Indiana University of Pennsylvania

Author: Rajendra Kumar Murthy

Dissertation Chair: Dr. Luis C. Almeida

Dissertation Committee Members: Dr. Mark J. Piwinsky
Dr. Jay Start

The purpose of this study was to examine the effects of learning strategies in a gaming environment. A sample of 207 students was recruited from an undergraduate business college in the fall of 2013 at the Indiana University of Pennsylvania. A pilot study tested the effectiveness of the instrument and an item analysis tested the efficacy of the questions.

The study was a 1x1 post-test design with one independent variable, learning strategies in a gaming environment with two levels Audio (narration) and Audio with Mnemonics. A one-way ANOVA analyzed the difference of means on achievement (test scores), between the three levels of the dependent variable. The levels were, the control group (CG) which did not receive any learning support, treatment group one (TG1) that received audio (narration) support and treatment group two (TG2) that received audio and mnemonic support, for two levels of the criterion tests, procedural (PKT) and conceptual (CKT) knowledge test consisting of twenty questions each.

The study was to determine (a) if there was any significant difference in scores between the two treatment groups and (b) if there was any significant difference in scores between the control group, treatment group one and treatment group two.

The experiment showed a significant main effect with respect to modality for procedural and conceptual items when compared to the control group. The results indicated a significant

difference in test scores for the three different levels of participants (CG, TG1 and TG2). $F(2,204) = 191.792$, $p < .0005$, $\omega 2= .65$

Post-hoc results using Scheffes' test for the main effect revealed that the increase from the CG to TG1 was 12.01, was statistically significant ($p = .0001$), and the CG to TG2 was12.30, was statistically significant, $p = .0001$).

The results suggest that students receiving learning support in a gaming environment score significantly higher compared to students in the control group not receiving support. It would be worthwhile to consider adding content to gaming environments along with traditional learning strategies to improve comprehension & retention.

ACKNOWLEDGEMENTS

In honor and memory of my mother Rachel Rueben-Murthy, who sacrificed her life, so that we could have ours.

To my father Ram Krishna Murthy whose support and struggle helped me achieve this opportunity.

A great BIG Thank You, to my INCREDIBLE wife Christine, who gave up her time and energy each day, so that I could complete this dissertation. Without her love and support, I would have never finished it.

To my family, Amanda, Brandi, Ashley, Maria, Tony, Ava and Sofia, who fill my heart with joy and give me a sense of purpose each day.

Thank You, to my families, near and far who supported me.

Thank You, to my students, who helped me in numerous ways each day.

Thank You, to my teachers Drs. Almeida and Piwinsky who supported, advised and helped me complete this dissertation.

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INTRODUCTION

"I know no safe depositary of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education" – Thomas Jefferson

Overview

The United States of America is the richest and most powerful country in the world. It is the wealthiest, with a per capita income of $37,790 at the beginning of 2013. GDP was $15,851 billion in 2012, and it spent $3,236 billion in 2012 (Fred, 2013) on its military, more than the next six countries combined. Americans hold more records in all disciplines than any other country. The overwhelming majority of Nobel Prize winners, scientists, inventors, entrepreneurs, and the wealthiest individuals in the world have historically been Americans. The cornerstones of this success and strength have been the population's literacy and its ability to create knowledge. People from all over the world come to the US for an education. Education is considered a right in this country, which guarantees American students a high school education at no personal cost for tuition or fees.

The US spends over $809.6 billion annually on education, more than any other country, with Japan coming in a distant second at $160.5 billion. The government spends $7,743 per student annually (Rossier Online, 2011). Despite this, trends over the past two decades have shown the US slipping slowly behind other developed countries in standardized test scores. American students rank third in the world in literacy among students 15 years and older, with Finland and Russia taking the number one and two spots, respectively. Several other countries have surpassed American academic success and this trend is continuing. American students are now ranked 10^{th} in mathematics, trailing (from 1^{st} to 9^{th}): Finland, South Korea, Canada, Japan, Australia, Germany, France, United Kingdom, and Russia. Additionally, the United States ranks 9^{th} in sciences, trailing (from 1^{st} to 8^{th}): Finland, Canada, Australia, South Korea, Germany, United Kingdom, and France (Rossier Online, 2011).

Educators, educational institutions, the government, and parents are all struggling to find answers and solutions to these falling standards. The Obama administration has promised to spend $69.8 billion on education in 2013, which is a 2.5% increase from 2012 (Washington Post, 2012), and has initiated several programs to reinvent the education system and attempt to reclaim its lost glory.

In the last 40 years, SAT reading scores for college-bound teens have been on a gradual decline, with the SAT scores for 2012 reaching a four-decade low. This raises doubts about the ability of college-bound teens to read passages and answer questions related to sentence structure, vocabulary, and meaning on college entrance exams. Educators and the education system are under attack and increasingly face serious calls from students, parents, the government, and institutions to reinvent themselves in order to reverse the downward spiral.

Since the advent of the first personal computer in the 1980s, the use of computer-based technologies has proliferated faster than any other technology. Computers that were once the domain of large companies and elite groups are now readily available to any person wanting to use them. Computers are faster, cheaper, smaller, and provide increasingly greater functionality.

Technology has matured and become ubiquitous in our daily activities. People both young and old are embracing the use of technology at a rapid pace, exploiting it for personal, professional, and social activities in many aspects of life. The younger generation has surpassed skill acquisition obstacles and adopted digital citizenship. However, digital technologies have created a generation that is easily distracted and has a short attention span (Purcell et al., 2012). The Internet, though a seemingly infinite source of information and knowledge, potentially serves as a distraction (Almeida, 2013). Some teachers agree that today's digital technologies are distracting students rather than helping them academically. Others argue that students are too "plugged in" and need to spend more time away from digital technologies (Almeida, 2013).

In 2008, Americans consumed digital information for about 1.3 trillion hours, an average of 12 hours per day. This consumption totaled 3.6 zettabytes, or 10,845 trillion words. This corresponds to 100,500 words and 34 gigabytes for an average person on an average day (Bohn & Short, 2009). There was a rise in media supply to US homes from 50,000 minutes per day in 1960 to about 900,000 minutes in 2005. The ratio of supply to demand has also risen significantly (Neuman, Park & Panek, 2012).

As data grows exponentially, students will have to find ways to harness technology to their advantage. Instead of getting distracted they will have to learn to pay attention, encode, and recall information if they plan to succeed in the information age. Educators and educational institutions are trying to find every viable medium to reverse the negative trends in academic performance because only an educated people can sustain and build a thriving economy. There is a direct correlation between an educated populous and the prosperity of a country. When education fails, in time all else will fail with it.

In recent years, educators and educational institutions have discovered a medium already embedded in our society that has exploded in popularity due to its ability to depict life-like structures, environments, and personalities (Squire, 2003). This medium is electronic gaming, a form of entertainment that has transmuted from arcades to the personal desktop, and most recently to mobile electronic devices. Gaming has gained an eminent presence in society as it occupies the top entertainment media spot. Kirriemuir (2002) asserted that the gaming industry is fast rivaling the music and film industries in all aspects. As of 2002, it was generating revenues of $20 billion on a yearly basis. Ernst and Young (2011) observed that between 2004 and 2008 the gaming industry witnessed an acceleration in its upward trajectory, with an estimated revenue growth of 24% annually. Gugel (2011) estimated that as of 2010, the worldwide video gaming industry was valued at $42.1 billion, and extrapolated that by 2014 the market will be worth $54.4 billion. The most notable gaming market segments are mobile games, social games, online-free-to-play games, online-subscription, PC games, and console games (Gugel, 2011).

Social scientists observe that games form a fundamental aspect in human lives in that they assist humans in expressing thinking patterns, behaviors, expressions, and ideas. Games require the use of both physical and mental strength, well-defined rules and procedures, and the attainment of goals through skills or chance. Contemporary games are instructional, interactive, or computer enabled (Hogle, 1996). In video games, educators have found a new mode of imparting the knowledge and understanding necessary for learning. This mode of technology has ushered in a form of interaction that requires attention, skills, collaboration, communication, and cooperation. The personalized, adaptive, and interactive nature provides an ideal platform for learning. Alan Gershenfeld, the founder of E-Line Media, a company that publishes digital games to help kids and parents learn, has argued that video games create deeper engagement and relate to interesting trends in education such as project-based or problem-based learning, personalized learning, and 24/7 learning (Prensky, 2000). Game-based learning does not replace the teacher, but rather supports teachers who have to manage children’s learning at different paces with different goals (Salazar, 2011).

Educators have already started examining and integrating gaming environments in their classrooms with largely positive, yet still somewhat mixed, results. Research at several levels of gaming is underway to validate educational gaming as a viable medium to impart knowledge and facilitate learning. This study examined learning by manipulating educational strategies that have been found to be useful in traditional learning environments, specifically, the use of mnemonics and narration. The researcher applied these strategies in a gaming environment to investigate whether the strategies complemented the achievement of different educational objectives. There have been a limited number of studies conducted, that have investigated the effectiveness of different learning strategies in a gaming environment, which justified the need for more research in this area.

In order to master complex concepts, students must stay focused, engaged, and motivated for extended periods (Bos, 2001). Unfortunately, the community of scholars does not have a good understanding of the process of creating and sustaining such engagements. Learning strategies can stimulate connections between new information and information previously stored in long-term memory (Driscoll, 1998). By manipulating different instructional strategies in a gaming environment, it was hypothesized that these strategies would assist students in making more solid connections between new and previous information, and consequently would assist with information processing (Almeida, 2008).

Theoretical Framework

This study proposed an investigation of how traditional learning strategies could apply in a gaming environment to help learners comprehend, encode, and store information in long-term memory for appropriate recall and use. Information processing provided a theoretical framework for explaining the events occurring in the human mind when it receives and processes information, and for determining the availability of such information for long-term use (Gagne, 1985). The ability to apply information for future use directly relates to the nature of the information processing during information retrieval and recall (Pape & Wang, 2003). Another important concept within information processing is the depth at which it occurs. According to Anderson and Reder (1979), subjects engaged in deeper processing will perform better than those who are not. Anderson and Reder's point is particularly important to the experiment conducted here because the control group did not receive additional support. Consequently, one might predict that the performance of the control group would be significantly less than that of the treatment groups that had received learning support (see Table 11). Anderson and Reder (1979) argue that rich elaborations affect human performance. With the exception of the control group, the subjects received rich elaborations in the experiment through Audio and Audio with Mnemonics. Arguably, the activities that the learners engaged in while processing the information relate to how the learners retrieved information (Cameron, 2004).

In the research, some of the functionality and limitations of the human memory can be explained with the conceptual model provided by the Information Processing Model (IPM). The model has had a major impact on instructional theory and practice. Sweller and Chandler (1994) developed the cognitive load theory, which explains the different instructional and learner constraints that affect optimal information processing. The authors argued that learning tasks impose some degree of cognitive load on learners to which available cognitive resources or learner-based strategies apply, such as selective attention and automaticity. The theory has assisted in planning instruction and developing learning materials. From the IPM model, Mayer and Moreno (2003) developed frameworks for increasing learning by systematically reducing cognitive load through better design of learning materials and strategic use of limited resources.

Consequently, information-processing theory has emerged as the basis of studying human cognitive development (Driscoll, 2000). According to information processing theorists, computers share the same model as the human mind, as the mind also processes information using logical procedures, rules, and mechanisms (McLeod, 2008). In the learning context, instructors and educational philosophers have been concerned with the learning patterns of individuals. Lutz and Huitt (2003) opined that when educators understand how learners acquire knowledge and retain information already obtained, they are able to plan effective knowledge transfer mechanisms and develop long-term learning objectives. According to Schraw & McCrudden (2013), IPM serves as a mechanism for retrieving and storing knowledge from memory and facilitating learning.

Information Processing Models: Dual-Coding Theory

Information processing theory has emerged through the study of cognitive development in the field of psychology. The basis of the theory is the idea that humans process the information they receive, rather than merely respond to stimuli (Bandura, 1977). According to the standard IPM for mental development, the mind's machinery includes attention mechanisms for bringing information in, working memory for actively manipulating information, and long-term memory for passively holding information so that it can be used in the future (Gray, 2010).

Allan Paivio (1971) developed one branch of IPM called dual-coding theory at the University of Western Ontario. According to Paivio, there are two ways a person can expand on learned material, namely, verbal associations and visual imagery. Dual-coding theory postulates that both visual and verbal information can represent information (Sternberg, 2001). Researchers believe that the mind processes visual and verbal information differently and along distinct channels in the human mind, creating separate representations for information processed in each channel. *Imagens* process mental representations, while *logogens* are concerned with the processing of verbal constructs (Lutz & Huitt, 2003).

Paivio further suggested there are three separate types of processing and interaction between the verbal and nonverbal systems, namely, representational, referential, and associative. Under representational processing, stimuli directly activate one system or the other. Referential processing activates one of the sub-systems based on the stimuli of another sub-system. Kearsley (2001) stated that information processing representation theories should take into consideration the dual functionality of human cognition in that a human mind is able to process concurrently both verbal and nonverbal constructs.

This study could benefit learners, especially those who have to comprehend, retain, and apply large amounts of information. This study could help identify, understand, and manipulate different traditional instructional strategies i.e. Audio and Audio with Mnemonics cues as independent variables in a gaming environment.

Learners in schools, colleges, universities, corporations, and various other organizations who are required to learn and retain information for critical thinking and actions should benefit from the findings of the study. Quality of service or product is dependent on the knowledge of the people producing such services or products. Institutions could find this study beneficial for complementing their learning systems by employing interesting and engaging games to educate their workforce. The net effect of an educated workforce would not only benefit companies but society as a whole. Prior studies (Cameron, 2004; Almeida, 2008) have found that gaming as an environment has produced significant differences in test scores relating to different educational objectives.

This study attempted to find direct associations and causal relationships between learning strategies and educational outcomes in a gaming environment. Manipulation of independent variables that provide positive results could allow companies to use games for training, potentially improving the quality of their services and products.

Statement of the Problem

The National Venture Capital Association (2011) noted that capital investments in education technology, including learning games, tripled in the last decade from $146 million in 2002 to an estimated $429 million in 2011. Further, Richards, Stebbings and Moellering (2013) noted that in 2009 the funding increased by $150 million, compared to 2008. Eight percent of federal funds to each education district supported educational supplementary programs and services including education technology.

Limited research exists to determine whether gaming has value as an educational tool. Consequently, little research is available on migrating some of the proven learning strategies found in traditional education. It is, therefore, premature to conclude that gaming positively influences learners' educational outcomes when used as an environment. Use of games in education could result in unintended problems. Squire (2003) argued that the use of games in education might not provide academically fulfilling experiences to all learners. Learners might not grasp knowledge content from the intricate gaming environment, thus jeopardizing effective learning and positive educational outcomes. Games could develop creativity, general reasoning, comprehension, and decision-making skills in students, but not necessarily the special content knowledge or the desired reasoning and decision skills that are intended to be cultivated during instruction.

Inversely, Kirriemuir (2002) surmised that growing pedagogical evidence shows that games enhance learning outcomes when effectively adapted for the learning atmosphere, thus serving as educational tools. There has been a lack of empirical studies investigating the relationship between gaming and educational outcomes. There has also been a significant lack of research determining the use of traditional learning strategies, such as narration and mnemonics, in a gaming environment. This study attempted to address these problems.

This study's guiding research question was would undergraduate business students majoring in Business at Indiana University of Pennsylvania (IUP) score significantly higher on tests if they receive mnemonics and/or narration support.

The Purpose of the Study

Gaming environments have proven to enhance efficacy in learning in some cases. The use of mnemonics has been the subject of studies and the basis of a well-studied and established learning strategy in traditional environments (Bruno, 2012). However, little research investigating the former variables in a gaming environment exists. Consequently, researchers have not yet established whether traditional learning strategies can be adapted to gaming environments to improve student achievement. This study aimed to investigate the role of narration and mnemonics in achieving conceptual and procedural knowledge in a gaming environment. The study intended to answer the question of whether or not well-established traditional learning strategies could be meaningful and help users enhance their learning through an interactive gaming learning experience

Types of Knowledge

Conceptual knowledge is the knowledge of classification, principles, generalizations, theories, models, or structures pertinent to a particular disciplinary area (Anderson & Dill, 2000).

It is the knowledge of understanding and relationships, where the understanding of connections and relations between discreet ideas is as important as each idea. Memorization is not applicable to such knowledge acquisition and must be acquired through thoughtful understanding. A person can have a conceptual understanding without having any procedural knowledge.

Procedural, or implicit, knowledge is the knowledge of how to do something. It is knowledge that is directly applicable to a task (Theory of knowledge, 2014). Procedural knowledge is acquired through rules and systematic instructions on how to accomplish a task. Knowing how to swim or drive, requires procedural knowledge. Most human knowledge exists in the procedural form (Yilmaz & Yalcin, 2012). This study advances the branch of procedural knowledge.

Instructional Strategies/Treatment

The two instructional strategies are mnemonics and narration. Narration is defined as the process of verbally narrating a set of events or processes. Mnemonics is defined as a learning technique that helps the learner recall information. The control group consisted of subjects who did not receive any strategic learning support. They received the learning content in traditional text format and were asked to take a test on the content immediately afterwards.

The treatment groups consisted of subjects who received learning support in the form of narration or narration and mnemonics. Both treatment groups received strategic learning support in a casino-style gaming environment. They were instructed to bet on the answers as they practiced. The gaming environment was enjoyable, interactive, and engrossing.

The first treatment group received the learning content in a narrative form. A pre-recorded female voice read the content. After the narration was completed, subjects played the game. During the game, a female narrator read some of the test questions and answers back to the subject. After playing the game, subjects were asked to take the criterion measures.

The second treatment group received the learning content in a narrative and mnemonic form. A pre-recorded female voice read the content to the subjects. After narration was completed, subjects played the game. During the game, a female narrator read the test answers back to the subject. During the game subjects received a mnemonic hint elaboration.

Research Hypotheses

H_o 1: There will be no significant difference in subject achievement on criterion tests between the two independent variables: narration and narration with mnemonics.

H_o 2: There will be no significant difference in subject achievement on criterion tests between the treatment groups and the control group.

Significance of the Study

Zin and Wong (2009) observed that there is a lack of research in educational technology to aid in the development of a gaming environment that simultaneously offers fun, entertainment, and learning content while fostering knowledge construction and deeper content understanding. There is a need for empirical data to substantiate the usefulness of gaming as an effective educational tool in a fun and educating fashion. This study is significant because it helps close this gap.

This study also attempted to validate whether business entities could use established traditional learning strategies effectively within the gaming environment as a training strategy. This study has significance because it contributes to the advancement of information processing theories, cognitive learning strategies and their efficacy in a gaming environment. It adds to existing empirical data, helping build a case for the future use of gaming environments in the delivery of knowledge. The availability of such data could assist policy makers in creating new legislation that would incorporate varied learning strategies in order to reach a diverse population of learners.

Terms and Definitions

Active learning. Defined by educational scholars, active learning is any instructional method that engages students in the learning process (Prince, 2004).

Cognition. Refers to conscious mental activities, including the activities of, thinking, understanding, learning, and remembering (Webster, 2013).

Cognitive load theory. This is an instructional theory that starts from the idea that working memory is limited with respect to the amount of information it can hold, and the number of operations it can perform on that information (Van Gerven, Paas, Merrienboer, Hendriks & Schmidt, 2003).

Cognitive theory. Ascribes a central role to cognitive processes in which the individual can observe others and the environment, reflect on that in combination with his or her own thoughts and behaviors, and alter his or her own self-regulatory functions accordingly (Burney, 2008).

Conceptual knowledge. Refers to the process of incorporating a new idea into an established schema or the re-organization of an existing schema to fit a new idea. It is also goal-directed, as opposed to being merely responsive (Skemp, 1989).

Dual-coding theory. This theory explains that the visual, auditory, and haptic modes can each encode information both verbally and nonverbally, and that presenting verbal and nonverbal elements together improves recall (Rosen, Fullwood, Henley, & King, 2012).

Electronic gaming. A device or computer game that provides entertainment by challenging a person's hand-eye coordination or mental abilities (Lucas-Stannard, 2003).

Imagens. Non-Verbal system units are called imagens. Imagens contain information that generates mental images such as natural objects, holistic parts of objects, and natural grouping of objects. Imagens operate synchronously or in parallel; thus all parts of an image are available at once (Paivio, 1986).

Interactivity. The degree to which two or more communication parties can act on each other, on the communication medium, on the messages, and on the degree to which such influences are synchronized (Liu & Shrum, 2002).

Linguistics. The scientific study of language (Denham & Lobeck, 2010).

Logogens. Verbal system units are called logogens; these units contain information that underlie our use of the word. Logogens operate sequentially, words come one at a time in a syntactically appropriate sequence in a sentence (Paivio, 1986).

Memory. The power or process of reproducing or recalling what has been learned and retained, especially through associative mechanisms (Webster, 2013).

Meta-cognition**.** This term refers to individuals' knowledge of their own cognitive processes and their ability to control these processes by organizing, monitoring, and modifying them as a function of learning. It refers to the ability to reflect upon the task demands and independently select and employ the appropriate reading, writing, arithmetic, or learning strategy (Educational Performance Systems Inc., 2005).

Method of loci. The oldest known mnemonic strategy ("loci" is the plural of locus, which means location or place). Its basis is the assumption that one can best remember places with which one is familiar (Richard, 2007).

***Mnemonics*.** An instructional strategy that helps students improve their memory of important information. This technique connects new learning to prior knowledge using visual and/or acoustic cues. The basic types of mnemonic strategies rely on the use of key words, rhyming words, or acronyms (Mastopieri & Scruggs, 1998).

Morpheme. A word or a part of a word that has a meaning and that contains no smaller part that has a meaning. (Merriam-Webster, 2013)

***Narration*.** The act or process of telling a story or describing what happens (Webster, 2013).

Procedural knowledge. The knowledge of operations and the conditions of use to reach certain goals (Byrnes & Wasik, 1991).

***Rehearsal strategies*.** Strategies using repeated practice to learn information and tasks. (University of Kansas, 2009).

***Stimuli*.** Events or occurrences in the environment of an organism that influence its behavior. The singular form is “stimulus” (Business Dictionary, 2013).

Theoretical framework. Structure with four major components: the hypotheses, the theoretical model, the research methodology (to be used to answer the hypotheses/research questions), and a well-defined literature review (supporting the focus of the research) (Ocholla & Le Roux, 2011).

Type II error. This type of error occurs upon failure to recognize a true effect (Lieberman & Cunningham, 2009).

CHAPTER 2

LITERATURE REVIEW

Theory of Cognition

Cognitive theory is concerned with understanding how human mental processes work. Cognitive theory attempts to analyze how individuals retrieve, process, and receive information from memory (Pape & Wang, 2003). This study has contributed to the advancement of information processing by introducing two learning strategies in a gaming environment to assist with the achievement of different educational objectives.

Scholars credit Kurt Lewin with developing the field theory of cognitivism in 1951. Among theorists who have contributed to the development of cognitivism are Benjamin Bloom in 1956, Robert Gagne in 1974, and more recently, John Robert Anderson in 1999. The theory states that learning is a culmination of changes in cognitive structure, identity or sense of belonging, and muscle control (Glenzer, 2005). In 1956, Benjamin Bloom described the domains of learning as cognitive, psychomotor, and affective. In 1974, Robert Gagne hypothesized the information processing theory, which categorized intellectual skills into eight levels, namely, signal, chaining, verbal association, multiple discrimination, stimulus response, principle formation, concept formation, and problem solving (Campbell & Jorda, 2005; Glenzer, 2005). Recently, in 1999, John Robert Anderson proposed that learning is a process that entails storing information in the form of meanings and ideas in the human mind (Glenzer, 2005).

Educators and scholars predicate learning under the Information Processing Model (IPM) as a mechanism of obtaining, storing, and retrieving knowledge from the memory. The cognition process, therefore, is a study area that is of interest to both psychologists and educationists. Cognition has been described as the body of knowledge that studies how individuals acquire and use knowledge through encoding, storing, and retrieving information (Lutz & Huitt, 2003), and these processes have been observed to occur in the mental faculties of learners.

Cognitivism and Learning

Cognitive theorists believe that learning is affected by the internal mechanisms of a learner and that learning is a process that is affected by cognition—thought, memory, perception, and information structuring. Similar, observations were highlighted by Mayer (2002) who stated that cognition and learning processes are intertwined. Hunt, Ellis, and Ellis (2004) highlighted that cognitive learning is an individual-centered active process that involves acquiring information, interpreting the information using known domains, and recreating the information into new ideas and insights. Initially, scholars studying the learning process ignored internal mental mechanisms. Instead, they concentrated on actions and behaviors of the learner (Glenzer, 2005). According to Glenzer, cognitivism advocates that the learning process is a product of cognitive activities. According to Almeida (2008), cognitive theory is concerned with studying human mental activities through understanding mental processes that include receiving, processing, and retrieving information. Effective deployment of these mental processes results in learning efficacy. Sincero (2011) pointed out that cognitive learning theory is concerned with explaining the role of the brain in information processing and interpretation during the learning process. Cognitivism as the basis of studying the learning process began in the 1960s and, following this, various theories have emerged within learning research. Sincero, in explaining cognitive learning theory, stated that cognitive learning theory (CLT) studies mental activities and the effects they have on the learning process. The root of CLT is the premise that mental processes influence learning processes, and analyzing mental processes forms the basis of understanding different processes of learning. Therefore, successful learning requires effective cognitive mechanisms to store new information in long-term memory.

Extensive research in the past decades has yielded different types of cognitive learning strategies. Paris, Byrnes, and Paris (2001) observed that cognitive learning strategies consist of mental strategies and external strategies. Mental strategies involve strategies that facilitate creation of mental images and models of the information that reading produces, while external strategies involve strategies such as note taking. Salovaara (2005) asserted that a strategy can either be applied in a specific subject or learning task or can be applied in a general area. Cognitive learning strategies can be categorized into the following sub-domains: rehearsal, organizational, elaboration, meta-cognitive, and affective. Weinstein and Mayer first adapted this categorization in 1986 (as cited in Salovaara, 2005) and studies in cognitive learning strategies continue to postulate it. The author of this study, advances rehearsal-learning strategies in a gaming environment.

Salovaara (2005) stated that rehearsal strategies entail activities that mimic the information material in some ways. The common tasks of rehearsal strategies include constructing acronyms, copying information, and underlining information. Organizational strategies involve processes of collecting, grouping, and organizing information to give meaningful categories. Next comes, the delineation of a concept map to use in the learning process. Elaboration strategies entail mechanisms that a learner uses to make the information clearer or connects the acquired information with personal experiences or meaning to understand further the acquired information. Salovaara (2005) went on to list activities for elaboration strategies. Salovaara's (2005) list included summarizing the acquired information and relating newly acquired information content to already existing knowledge domains. Metacognitive strategies involved activities that direct learners' cognitive processes. These activities included evaluating cognitive strategies as used in the learning process, checking understanding of the content, self-questioning, and monitoring the learning process.

Information Processing Theories

Information processing theory has emerged as the basis for studying human cognitive development. According to information processing theorists, the computer and the human mind both process information using logical procedures, rules, and mechanisms (Driscoll, 2000). In the learning context, instructors and educational philosophers are concerned with the learning patterns of individuals. Lutz and Huitt (2003) opined that if educators understand how learners acquire knowledge and retain information already obtained, they would be able to plan effective knowledge transfer mechanisms and develop long-term learning objectives. Educationists and scholars, therefore, conjecture learning under the IPM as a mechanism of obtaining, storing, and retrieving knowledge from a permanent knowledge repository, namely, the memory.

Cognitivists believe that mental mechanisms and structures are the primary influences on the learning process. Langan-Fox, Armstrong, Balvin, & Anglim (2002) pointed out that memory is the fundamental module in information processing. Memory is critical in the learning process since it controls learning development and retention of knowledge (Comeaux, 2005). Lutz and Huitt (2003) highlighted that cognition scholars believe that memory and the brain play critical roles in information processing. However, there are differing views on how the brain manipulates information that is later stored in memory. Scholars have described information processing as a cognitive perception that utilizes thinking mechanisms. The mechanisms entail reasoning, information storage and retrieval, and memory utilization (Sternberg, 2006). Under the information processing approach, scholars have created different definitions of memory.

Sweatt (2010) and Driscoll (2001) observed that the memory system is categorized as either declarative or non-declarative and should be described based on the following characteristics: brain mechanisms, the type of information the memory processes, and the principles of operations. Declarative memory is essential in forming memories of names, facts, personal experiences, and places. On the other hand, non-declarative memory entails memories of motor learning, sensitization, and delayed classical conditioning. In essence, scholars have defined memory as a combination of all human mental occurrences that have been accumulated over one's lifetime and can be retrieved in various ways. Eliasmith (2001) held the view that memory should be described as the ability to change occurrences of the world through effective interpretation and perception of the world. As highlighted by Sheehy and Forsythe (2013) and Winn and Snyder (2001), based on the works of Sir Fredrick Charles Bartlett, it is reasonable to conclude that the memory is ordered into structures. These structures account for the various properties of memory that are not visible in simple tasks but that enable people to derive different meanings for different incidences.

Information Processing Models: Dual-Coding Theory

Proposed in 1971 by Paivio, dual-coding theory is built on the assumption that information is processed and stored in memory by two separate but interconnected codes: one verbal (linguistic information, or "logogens"), the other nonverbal (nonlinguistic information, or "imagens"). Both verbal and nonverbal systems operate independently, yet there are interconnections between the two systems that allow connections between the two codes. The verbal and nonverbal codes form the basis of storage of information in the memory. This memory is the basis of the covert and overt skills acquired by organisms that are essential for survival (Sheehan, 2008; Paivio, 1971, 1986; Sadoski & Paivio, 2001). Sheehan (2008) identified three distinct levels of processing that can occur within and between the verbal and nonverbal codes: representational, referential, and associative. Representational processing entails the recognition of something that is familiar to the individual's memory, while associative processing entails making connection with an activated logogen with at least one morpheme. Referential processing occurs when meaningful connections become active between verbal and nonverbal codes.

As described by Ausman (2008) and Sadoski and Paivio (2001), representational processing involves direct connections between incoming stimuli and either the verbal or nonverbal code. A verbal stimulus directly activates verbal memory codes, and a nonverbal stimulus activates nonverbal memory codes. Referential processing refers to the building of connections between the verbal and nonverbal codes. Associative processing refers to the activation of informational units within either of the systems. As stated in the cognitive load theory, novices without appropriate schemas face challenges in recognizing and memorizing problem configurations. These challenges thus force novices to utilize weaker problem-solving approaches like means-end analysis. This forces such individuals to use excessive resources in finding solutions. This study is an attempt to close this gap.

A given task may require any or all three forms of processing. The superiority of pictures used in verbal memory tasks finds explanation in dual-coding theory with a foundation in two important assumptions. The first is that the two codes (verbal and nonverbal) produce additive effects. This means that if the coding of some piece of information takes place both verbally and nonverbally, this doubles the probability of retrieval. The second assumption involves the ways in which pictures and words activate the two codes differently. Researchers believe that pictures are far more likely to be stored both visually and verbally (The Power of Visual Communication, 2004). That is, we remember the picture and its spontaneously associated name. For example, a picture mnemonic of a cowboy boot with a letter layered over top of it provides adequate cueing in both verbal and nonverbal memory.

Researchers also generally believe that primary codes for concrete concepts are learned before, or more easily than, abstract concepts (White, T. 2006). This is because the mind processes concrete concepts and stores them as images and verbal representations, whereas the process for abstract concepts results in storage as verbal representations, which have less access to the nonverbal code. In this regard, researchers believe that foundational literacies form the base for new literacies where such learning aspects as decoding, response, and comprehension rely on previously acquired knowledge (Leu, Jr., D. J., & Kinzer, C. K., 2000). Primary codes lead to the development of foundational literacies, while new literacies are characteristic of secondary codes (Sadoski & Paivio, 2012; Sadoski, Paivio, & Goetz, 1991).

Information Processing Theory in Learning Contexts

Lutz and Huitt (2003) indicated that understanding how learners store and process information is vital in facilitating the design of effective knowledge dispersal mechanisms. Once an instructor establishes how a learner processes information, it is easier for the instructor to design instructional methods that will aid in the effective delivery of knowledge. Scholars posit that effective learning occurs when acquired learning information is stored and retained in the long-term memory (Lutz & Huitt, 2003). This results only through elaboration and connection of new information and learned information in the memory. However, all effective learners use three general strategies in most situations. These include organization, inferences, and elaboration (Mayer & Moreno, 2003). Organization refers to the sorting and ultimate arrangement of information in long-term memory. Information similar to what one already knows is easier to encode and retrieve than isolated information. In some cases, individuals already possess well-organized knowledge with "empty slots" that await new information. Activating existing knowledge prior to instruction, or providing a visual diagram of how information is organized, is one of the best ways to facilitate learning new information (Gregory Schraw & Matthew McCrudden, 2013). Constructing inferences involves making connections between separate concepts. Elaboration refers to increasing the meaningfulness of information by connecting new information to information already known.

Huitt (2003) made similar observations when he indicated that elaboration and distributed practices are two processes that move knowledge to long-term memory. Lutz and Huitt (2003) asserted that long-term memory stores and retains information as a function of the depth of its processing and the extent of the connections between the new knowledge and the stored knowledge. Consequently, learning methods, like the ones used in this study, should present knowledge in ways that allow students to, easily connect existing knowledge with new information. Huitt (2003) explained that in the learning process elaboration occurs in the following ways: imaging, pegword, rhyming, initial letter, and method of loci. In this study, the researcher used initial letter mnemonics.

Kessels (2003) stated that information processing in a learning context takes place through various stages. For example, a learner first perceives the information, interprets it, and later, when required, remembers the information. Scholars have asserted that the first stage in memory mechanisms involves paying attention to the stimuli (Vuilleumier, P., 2005). Therefore, attention is a critical activity in the learning process. Once learners have directed their attention to the environmental stimuli, the second stage begins, which involves the senses processing the new information. For effective learning, an instructor should first ascertain the presence of all sensory mechanisms and then use the learners' preferred sensory mode. The processing of information requires visual, motor manipulation, and auditory as main sensory mechanisms. The third stage involves encoding information. In this stage, the information is altered and encoded into either the short or long-term memory. In the short-term memory, humans hold information for a short period and thereafter forget it. In the long-term memory, information finds storage in an enduring format (Driscoll, 2000).

The organization and storage of information in long-term memory is strategic and may include rehearsal, imagery, or small functional units. The final stage in the information processing system entails actions that a learner makes using the information they have processed and stored. Kessels (2003) affirmed that education is concerned with helping a learner process and store the information needed. If errors occur during the learning process, a learner is aided in efficient ways to process, retain, and retrieve the required information.

Learning is a process of receiving, processing, coding, storing, and retrieving information from memory structure (Lin & Dwyer, 2004). Human memory consists of three processing categories: sensory memory, short-term memory, and long-term memory (Atkinson & Shiffrin, 1971; Mayer et al., 2001). These memories are limited in terms of capacity and duration. Therefore, not all the information entering the memory structure registers in long-term memory structure in schema form (Chandler, 1995). Two channels process information that enters into the memory structure: a visual channel that processes information such as pictures and a verbal channel that processes information such as narration and text (Paivio, 1986; Mayer et al., 2001). Since duration and capacity limit human memory, placing a high cognitive load on one channel may reduce its effectiveness (Mayer et al., 2001).

Conceptual knowledge is the knowledge of classification, principles, generalizations, theories, models or structures pertinent to a particular disciplinary area (Anderson et al., 2000). It is the knowledge of understanding and relationships, where the understanding of connections and relations between discreet ideas is as important as each idea. It cannot be memorized and acquisition has to come through thoughtful understanding. A person can have a conceptual understanding without having any procedural knowledge.

Procedural knowledge or implicit knowledge is the knowledge of how to do something. It is knowledge that applies directly to a task. The claims to know how to swim and how to drive are claims to have procedural knowledge. It is possible to know all of the theory behind swimming without ever touching water. People may know how to move their feet and hands and how to breathe while moving in the water. However, unless they enter the water and learn how to apply the theory, they cannot claim to know how to swim. Knowing how to swim implies the possession of a skill, which is different than knowing a collection of facts (theoryofknowledge.info, n.d.).

Is Gaming Good for Education?

Educational historians have affirmed that teachers and educators generally have employed games in teaching and learning processes throughout history, at all educational levels. Ulicsak and Wright (2010) affirmed that during pre-historic times, role-play and board games functioned as teaching tools. Baker and Boonkit (2004) stated that learning strategies comprise well-defined actions followed by learners to make learning effective, engaging, interactive, and self-directed. Educators and game developers have concurred that games can form an important pedagogical tool (Gee, 2003; Squire, 2005; Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005).

This is because games are engaging, interactive, foster teamwork among learners, and enhance understanding of complex knowledge content.

Chuang and Chen (2009) highlighted how digital games have revolutionized learning strategies. They recommended the use of a Monopoly game to help students learn math for remedial instruction. The game was broken down into several small learning units and students progressed as they mastered the learning units. In this study, the learning was facilitated by a gaming environment, and because of this, students who struggled in traditional math classes did significantly better after they went through the game, as compared to a traditional classroom environment. Educators have observed that the use of games in a learning environment contributes to active learning, interactivity, motivation, skill nurturing and development, peer learning, and teamwork. Almeida (2008) asserted that learning strategies in a gaming environment could offer indispensable tools in facilitating effective information processing.

Gaming in an Educational Environment

Games are a more natural way to learn than traditional classrooms, noted Aldrich (2009), who ascribed the motivational effect of digital games from "the emotional appeal of fantasy and sensory and cognitive components of curiosity." Aldrich further claimed that knowledge is only useful in context, and that virtual environments provide an emotional context in which it is necessary for new content to be absorbed. If, at the time, the user has an emotional commitment to the content (game), chemicals enter the amygdale and hippocampus that trigger the memory (Ledoux, 1998). The persistent involvement in games would suggest that users are emotionally involved. The emphasis is on the interaction. Researchers have demonstrated repeatedly that interactivity is a very powerful education tool (Prensky, 2000; Pesce, 2000; Berger, 2002; Gee, 2003; Squire & Jenkins, 2004; Steinkuehler, 2005).

According to Ulicsak (2010), gaming as a learning tool has been gaining recognition in various environments, namely, education, health, military, and vocational settings. Serious games, as educators call them, are games that have an educational intent. The gaming environment includes simulation and virtual worlds. Learning in these environments is either implicit or explicit, and the environment in which the game is played engages learners, though not always pleasurably. For example, in the military environment, the use of training simulations provides a harmless, cost-effective way to train for activities in a synthetic, non-dangerous environment that is engaging but is not necessarily pleasurable.

Moreover, training simulations offer a platform for learners to engage in situations that would be time and labor intensive to establish in the real world (Ulicsak, 2010). For example learning to fly a Boeing 747 requires hundreds of hours in the cockpit with the aid of an accomplished instructor. Both these resources are economically unfeasible, whereas use of a flight simulator makes training affordable and safe. As a result, gaming environments are instrumental in educational settings in facilitating effective learning. In the field of medical instruction, serious games find use in teaching medical students complex medical procedures and technical knowledge. For example, performing a complicated heart surgery would be resource intensive at every level, and creating a simulation of the event and allowing the subject to practice their skills until they have gained mastery would save time, resources, and most likely lives.

Barab et al. (2005) postulated that effective learning should encompass domain-related activities and not be a regurgitation of other scholars' academic work. Gaming environments such as Quest Atlantis is a 3D learning and teaching experiment that employs a multiuser, virtual environment used for educational tasks. It combines strategies used in commercial gaming environments with lessons from educational research, on learning and motivation. It facilitates learners' engagement in experiential and inquiry-based learning. Experiential and inquiry-based learning allow learners to gain conceptual and procedural knowledge by learning through real-world participation and inquiry. Ulicsak (2010) posited that gaming environments have a developmental basis in different models of learning, such as behaviorism, cognitivism, and constructivism. This has facilitated knowledge transfer of factual, conceptual, and procedural knowledge to learners. The British Broadcasting Corporation (2002) asserted that gaming environments offer various benefits to learners as simulation games help learners develop critical thinking, reading, numerical, and other complex skills due to the challenging nature that requires problem-solving competencies. This study is an attempt to advance comprehension and recall using the challenging nature of games found in a gaming environment.

Lack of Research in Educational Gaming

Numerous studies have posited that there is a causation effect between gaming and effective learning (Cameron, B. (2004); Mayer, R. E., & Chandler, P. (2001); Prensky, M. (2000); Salazar, J. (2011); Squire, K., & Jenkins, H. (2004); Squire, K. (2005); Ulicsak, M., & Wright, M. (2010); Ulicsak, M., & Williamson, B. (2010)). However, some scholars have conjectured that it is inconclusive and pre-emptive to conclude that epistemic games facilitate learners in developing academic competencies. Support for such claims have not, yet, been supported by the majority of research in instructional technology. Presently, epistemic games are mainly engaging, but not entertaining. For example, epistemic games help players think in innovative ways by role-playing as professionals in various industries. However, such role-playing and acquisition of skills would have a negative affect due to the repetitive nature of that particular role. This makes them less appealing to learners who are looking for entertainment integrated with learning. Another aspect that poses a challenge in the research of educational gaming is the complex nature of educational games. Ulicsak (2010) pointed out that good educational games should illustrate interconnectedness of subjects. Carr-Chellman (2012) has called for the development of better games. Due to this complex nature, research is still ongoing to develop a good learning tool that bridges different subjects.

Learning Strategies in Gaming Environments

Chuang and Chen (2009) highlighted that digital games have revolutionized learning strategies. Similarly, non-digital games have also affected learning strategies. In the learning process, a learner uses two types of thinking processes, namely, visuospatial thinking and verbal thinking. A gaming environment most often consists of both visuospatial and audio inputs (Mayer & Moreno, 2003). Visuospatial thinking involves the process of selecting relevant images, organizing them into logical pictorial models, and integrating them with prior knowledge in long-term memory (Mayer, 2002). Similarly, verbal thinking process entails selecting relevant words, organizing the words into logical verbal models, and integrating the models with prior acquired knowledge from long-term memory. Mayer affirmed that effective learning takes place only when a learner uses both cognitive processes in the appropriate contexts. Examples of learning strategies in gaming environments include mathematics, science and complex learning systems.

Learning Strategies

Scholars have agreed that effective learning strategies are indispensable tools for achieving learning efficacy (Lou, Y., Abrami, P. C., & d'Apollonia, S. 2001). Learning, or meta-cognitive, strategies are general approaches that students employ in their learning process (OECD, 2010). Baker and Boonkit (2004) stated that learning strategies constitute well-defined actions followed by learners to make learning effective, engaging, interactive, and self-directed. Joan Rubin, a pioneer researcher in the field of language learning strategies, defined learning strategies as implements deployed by learners to amass knowledge (Griffith, 2003). Learners, therefore, deploy learning strategies to grasp information and thereafter use that information to solve problems. Scholars concur on the definition of learning strategy as an approach to learning and deploying the acquired information (Shunk, 2004).

In this study, the researcher investigated learning strategies only (Learning Strategies, n.d.). The learning strategies under investigation were mnemonics and audio (narration). According to the University of Kansas Center for Research on Learning (2009), an effective learning environment should incorporate assorted strategies for positive learning outcomes. There are numerous learning strategies tailored to meet diverse learning goals. For instance, strategies like paraphrasing, visual imagery, inference, word identification, and self-questioning are components of reading strategies. First-letter mnemonic, word mapping, paired associates, and the LINCS vocabulary are similar to strategies for storing and recalling information. Error monitoring, inspecting, paragraph writing, sentence writing, and theme writing are all related to strategies of expressing information. Despite the assertions by some scholars that there is no single learning strategy that guarantees students' educational success (deVincentis, 2010), it has been postulated that a learning strategy utilizing sound in knowledge dispersal is more effective than one using visual imagery (Clark, 2007). Consequently, some learning programs, such as e-learning courses, have incorporated audio narration in their programs to enhance the efficacy of the learning process. Other scholars have argued that audio educational media act as a distraction, interfering with information processing (Clark & Meyer, 2008). Sound may gain and focus learner attention, reduce distracting stimuli, and make learning more engaging, nonetheless, there is limited and inconclusive empirical research on audio strategies in the educational context (Bishop & Cates, 2001; Bishop, Amankwatia, & Cates, 2008). They found a lack in interface and instructional design that completely ignores sound. While several instructional designers are using sound only for literal, information conveyance they have not yet explored, how to exploit the associative potential of music, sounds effects and narration to help learners process the material under study more deeply. Research suggests instructional uses of audio remain largely unexplored. Therefore, the design of learning strategies should reflect diverse learning goals**.** This study attempted to fill this role.

Audio Narration

According to Muriel Rukeyser, "*The universe is made up of stories, not atoms.*" (The Speed of Darkness, 1913-1980). Audio narration could be more effective than visual imagery because the brain retains a visual image for a very brief period when the eye fixates on an object, but it retains sound for longer periods. This gives audio an advantage in sequencing and storing information in long-term memory. Audio is a natural form for revealing an incident. It captures the imagination of the listener, and has the ability to transform information into knowledge for longer retention (CommLab India, 2000).

Gibson (2007) asserted that narration is among the pre-historic learning strategies and even predates written words. It is estimated that narration as a form of teaching strategy was the predominant knowledge transfer mechanism for almost seven millennia before the invention of the first written language, which was attributed to the Sumerians in 3200 BC. Due to the efficacy and preference for audio as a learning strategy, narration still does dominate learning strategies. The use of audio in education has evolved from face-to-face, to tape recorders, to podcasting due to advancements in technology (Dennick, 2009). In contemporary learning institutions, podcasts offer audio narration learning strategies (Cebeci & Tekdal, 2006). Podcasting is the use of web-based protocols to deliver audio content to a targeted audience.

Dale (2007) observed that podcasts as an audio narration delivery conduit in learning settings enhance learners' engagement, interest, and reflection, consequently broadening learners' thinking horizons due to the affective nature of the audio environment. The advent of e-learning has sparked interest in audio narration as a learning strategy as educators incorporate voice-overs in texts and videos (Kim & Gilman, 2008). This interest in audio as a learning strategy is a result of different learners having diverse learning strategies, some learning effectively through texts, others through listening and discussions. Educators recognize narration to be a valid support for learning because it helps make sense of experience, organize knowledge, and increase motivation.

Narrative, in the form of stories and narrations, is increasingly a staple technique in education. Not only is it a natural expressive form for people of any age and culture, but narrative has been acknowledged as the basis of human cognition and the foundation for such human capabilities as meaning-making (Randy & McKeough, 2007; Bruner, 1990). Schank (2000) observed that narratives help individuals to work out a coherent meaning for their respective experiences (Bruner, 2003; Randy & McKeough, 2007). As a consequence, stories are being increasingly used in a variety of subjects, not only intuitively related ones such as history, literature, and language, but also in the scientific domain (Burton, 1996, 1999; Bruner, 2004).

Nesbit & Adescope (2011) also found that students who studied animated concept maps accompanied by concurrent audio narration recalled more information that those studied only the text materials. Spickard III, A., Smithers, J., Cordray, D., Gigante, J., & Wofford, J. L. (2004) found audio narration is an important aspect of online lectures, students in the audio-feed group achieved a trend for higher post-intervention scores compared to students who attended the same online content but did not receive audio-narration feedback.

Mnemonics

The word “mnemonic” comes from the Greek word “mnemonikos,” meaning, “relating to memory.” A mnemonic is a ditty, rhyme, or word based on the initial letters of a list of items—often where the order of the items is crucial—used as an aid to memory (Hunt, 2010). The word “mnemonic” entails the enhancement of memory, and this is the reason for exploiting them (So, C., Sim Chen-Hui, & Low Wei-Shan, 2012; Bourne, Dominowski, Loftus, & Healy, 1986). Mnemonic devices have proven effective in helping students to remember new information acquired in a learning set-up (Bakken, J. P., & Simpson, C. G. 2011). A learning set-up is an effective learning aid, especially for complex or abstract concepts, because it helps students remember concepts to which they previously had no exposure (Seay & McAlum, 2010; Joyce & Wiel, 1986). Research has found that mnemonic devices linking, new information to something already familiar to a subject is distinctly effective (Laing, 2010). Students knowingly or unknowingly have used mnemonic devices from an early learning stage. They are intuitive and most commonly used by parents and teachers as a simple yet fun method to help learners remember new things. Examples of mnemonics include the use of “HOMES” to represent the five great lakes: Huron, Ontario, Michigan, Erie, and Superior) and the use of “Please excuse my dear Aunt Sally” to recall the arithmetic order of operations: parentheses, exponents, multiplication, division, addition, subtraction.

Research has found (Carroll, 1994; Debrowski, Wood, & Bandura, 2001; Flood, 2003) that directive teaching strategies can improve learning in knowledge domains that are abstract and highly structured. The mnemonic approach is suitable to these specific domains as it engages the learner with the target items, which boosts the learner's memory and application of previously obtained knowledge in the acquisition of new knowledge (Gask, Coskun, & Baron, 2011; Kaiser, 2011; Nolan & Hoover, 2011; Sweller, 1999; Tuovinen & Sweller 1999). The educational literature is replete with research that identifies the benefits of the use of mnemonic teaching strategies. In particular, as put forward by Zisimopoulos (2010), Levin and Pressley (1985), and Wang and Thomas (1996), mnemonic devices have been found to accelerate the rate at which new information is acquired. One study showed that students who used mnemonic devices to acquire a second-language vocabulary were able to retain the knowledge longer in memory compared to those who did not (Wang & Thomas, 1996). Similar tests in other disciplines that required the memorization and recall of facts showed the same positive results.

Mnemonics are equally effective in boosting recall in the learning process. Mnemonics are effective in boosting retrieval in receptive learning, but can be even more effective in productive learning (Fritz, Morris, Acton, Voelkel, & Etkind, 2007). Mnemonics also help improve problem-solving tasks involving both analytical thinking and formal reasoning as they improve decision making due to effective reflection on past-learned lessons. They are also effective in reducing errors in the results arrived at by individuals in the performance of distinctive tasks (Bruno, Eric, Shah, & Linn, 2012). Research has also found mnemonics to be beneficial in boosting long-term memory, especially among the aged. Kaci, Fairchild, and Scogin (2010) found that a memory enhancement strategy led to significant improvement in test subjects remembering names with faces and reducing misplacement of household objects. Additionally, those using the memory enhancement technique reported being more content with their memory, having fewer lapses in memory, and were less bothered by memory complaints. In training activities, mnemonics play a major role in boosting memory and, consequently, in overall performance in the learning process (Derwinger, Neely, & Bäckman, 2005; Marschark & Hunt, 1989). It is precisely because of the former that first letter mnemonics were used as an independent variable in this research study.

The first-letter mnemonic is a strategy for remembering large amounts of information for which there is a need for recall at the right time and in the right context. Specifically, students identify lists of information that are important to learn, generate an appropriate title or label for each set of information, select a mnemonic device for each set of information, create study cards, and use those study cards to learn the information (Elearning Design, 2011). According to a study at The University of Kansas Center for Research on Learning (2009), students who learned the first-letter mnemonic strategy received test grades that increased from an average of 51% to 85% . Brown (2007) and Levin (1983) noted that there are "three Rs" of associative mnemonic techniques: recoding, relating, and retrieving. Recoding entails coming up with key items which have attributes similar to the subject item and which are concrete enough for easier memorization. Relating focuses on the possibility of linking the item selected with the subject information. Lastly, retrieving entails the ability to recover the learned knowledge in the form of a picture or a visual image in the next learning process.

A common example of a first-letter mnemonic is; when to-be-recalled items are successively linked together, either as an acronym, as in the earlier example of “HOMES” used to represent the five great lakes. Alternatively, a constructed phrase or sentence consisting of words beginning with those letters to cue the list items, as in the earlier example of “Please excuse my dear Aunt Sally”. Mnemonic devices are useful tools for students who are learning new material (Balch, 2005; Carney & Levin, 1998; VanVoorhis, 2002). Laing (2010) noted that mnemonics are effective in producing better results in learning for students who have utilized them. In most cases, students who have relied on mnemonics in learning have secured better marks in exams than have their counterparts. For example, Stalder (2005) provided several acronyms for use in introductory psychology (e.g., ABC for the three foci of psychological study: affect, behavior, and cognition) and demonstrated that students who used these memory tools performed better on exam questions about acronym-related material than students who did not use them. Students also reported that the instructor-provided acronyms encouraged them to study earlier for exams and made memorizing material easier. Stalder also found that although few instructors regularly use acronyms, they overwhelmingly believed that acronyms are helpful and acknowledged that students probably create their own.

In a recent study involving elementary accounting students (Laing, 2010) researcher found that mnemonic devices can accelerate the rate at which new information is acquired and improves formal reasoning, he further ascertained that some mnemonic devices (PALER vs. ALORE) are better suited than others due to their intuitive nature for recall.

CHAPTER 3

RESEARCH DESIGN

Introduction

The intent of this study was to investigate if students would score higher points in a test, if the content they had to comprehend and recall was supported by a learning strategy and integrated into a gaming environment. The study clearly showed that students in the control group who did not receive any learning support were out-performed by student who did receive learning support in a gaming environment by a statistically significant margin.

The researcher conducted an experiment, with post-test only design. In experiments, results are a snapshot of inferences at a particular time and in a restricted context (Philips & Burbules, 2000). Any actual domain of knowledge is first a set of acting and interacting to produce knowledge and a set of activities and experiences (Gee, 2009). This experiment stayed within the scope of such structure and exercised the deductive strategy analogous to experiments. As such, the experiment drew from the general to the specific and used a deductive process to generalize the findings based on a specific group of subjects. Business majors from the Eberly College of Business and Informational Technology were the subjects in this study; it is assumed that results obtained from this study could be applicable to all other business students. The study consisted of four main components:

1. The Lung module: The content for the lung module was adapted from Almeida (2011).
2. Item Analysis: Sixty-three business students participated in an item analysis test to remove questions that could be easily answered without prior knowledge as well as questions that all students got wrong because of its high level of complexity.

3. Pilot Study: A pilot study with 10 students per group (control, treatment group 1 and treatment group 2) was conducted to test the efficacy of the experiment. The pilot helped resolve any unforeseen issues and produced results that were anticipated from the main experiment.
4. The game: The game chosen for this experiment was the card game Blackjack. It had the elements of risk, challenge, and interaction that are mostly seen in games. Subjects would be able to risk $10, $50, $100 bets depending on their level of comfort based on their knowledge of the answer.
5. The experiment: On the day of the experiment, subjects logged into a computer and were randomly placed in one of the three treatment groups. Based on the online instructions, they were asked to either read the content as seen in a textbook or listen to a narrator who read the content to them. Based on their treatment group they either took a test immediately following the content or played a game of Blackjack, after which they took the test.

Development of Instructional Module

The researcher adopted the human lung content from the World Health Encyclopedia (The Respiratory System, n.d.) and used the criterion measures developed by Almeida (2011) in a computer based gaming format. The instructional module was based on a casino style game similar to Blackjack, where the subjects had the opportunity to learn the content of the human lung by betting game money. An element of competition was present during the subject's experiences with the instructional module. The module was developed with a combination of software tools and computer languages including Microsoft C++, SQL Express, Macromedia Flash, Dreamweaver and Fireworks. The researcher revised the game prototype twelve times prior to its implementation for research. Several ideas for game building were tried before settling with the Blackjack game. The prototype had to be designed and revised to include proper audio clips, narration, animation, color combinations, music and mnemonics. Timing of text and narration appearing on the screen had to be revised several times to ensure proper synchronization of content within the gaming environment.

Criterion Measures

The criterion measures were developed by Almeida (2011), each consisting of twenty items per test. The criterion measures were used to assess the subjects' achievement scores in all groups. In this study, all assessments and quizzes were administered in an online format to reduce any medium-based effects between the content and the assessment. Cronbach's alpha reliability coefficients for this study were: .842 for all forty items collectively (Procedural knowledge test (PKT) and Conceptual Knowledge Test (CKT). The Cronbach's alpha score for the procedural knowledge test (PKT) was .756 for twenty items. The Cronbach's alpha score for the conceptual knowledge test (CKT) was .708 for twenty items.

The conceptual knowledge test (CKT) contained twenty questions, each with five choices designed to evaluate subject's ability to identify the parts and the conceptual knowledge relating to the human lung. This test required subjects to understand the basic functions of the lung. Conceptual level objectives were addressed with this assessment. Each question had a value of one point. The test required additional validation as a standard operating procedure for experimental design studies in the social sciences. A pilot test was used to validate this procedure.

The procedural knowledge test (PKT) contained twenty questions with five choices per question, a multiple-choice test designed to measure procedural understanding of the contents of the lung. This multiple-choice test consisted of procedural knowledge comprehension of the human lung where subjects had to know the parts of the lung in order to answer procedural comprehensive questions. This test required subjects to have an understanding of how the lung works as well as knowledge of its parts. Subjects had to apply content in order to answer the procedural questions. Each question had a value of one point. The planned test required additional validation as this is a standard operating procedure for experimental design studies in the social sciences. A pilot test validated this procedure.

Expert Panel for Content Validation

The respiratory system content was adapted from the World Health Encyclopedia (The Respiratory System, n.d.). The content was verified by two medical health professionals for accuracy, relevance, and validity (see Appendix B).

Reliability of Criterion Measures

A Cronbach's Alpha was used to calculate and establish the reliability and consistency of the scores within the dependent variables. It is used to measure the internal consistency of the criterion measures, which is, how closely related the items were as a group in the experiment. A high value implies that the items are closely tied to each other and measure an underlying construct, i.e. CKT. SPSS version 22.0 was used to calculate all reported reliabilities. The reliability analysis is summarized below. The average Kuder-Richardson Formula Twenty Reliability coefficients from a random sampling of studies were 0.84 for all forty items and 0.76 for procedural knowledge and 0.70 for conceptual knowledge, respectively. See Table 1, 2 and 3. The score of 0.84 for all forty items is considered high and acceptable in social science, and hence implies that the items in the test measure the same concept and our inter-related within the test. Internal consistency ensures validity of the test.

Table 1

Reliability Statistics: Cronbach's for Forty Items

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.842	.842	40

Table 2

Reliability Statistics: Cronbach's for Twenty Items—Procedural Knowledge Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.755	.756	20

Table 3

Reliability Statistics: Cronbach's for Twenty Items—Conceptual Knowledge Test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.706	.708	20

Development of Instructional Materials

The content of this experiment dealt with the human lung (Almeida, 2011), and it took the form of an approximately 2,000 word instructional module dealing with the parts and functions of the human lung (see Appendix A). The material was used because it was designed and developed by Dr. Luis Almeida who is a professional instructional designer. The lung content had two tests: conceptual and procedural. The experiment's control group was strong, they were all business majors with minimal confounding effects on the independent variable. As a result a well-developed treatment would surpass the control group, reducing the chances of type II error.

Item Analysis

After selecting the lung model, the researcher performed an item analysis for this dissertation. Sixty-three business students participated in the item analysis portion of this study (see Appendix D). All subjects read the lung content, followed by two twenty questions criterion measures. Based on the item analysis results, the researcher removed questions 5, 11, 12, 13 and 17 from the Conceptual knowledge Test (see Appendix D). Any items with scores of .75 or higher were excluded from being included in the treatments to reduce statistical errors. These were questions that were easily answered by most subjects, without any prior knowledge of the lung. In addition, a number of questions in the conceptual knowledge test could not fit the mnemonics format and therefore, were dropped from this study as well (see Appendix D-Table 23). Based on the item analysis results, the researcher did not remove any question from the procedural test as there were no items over .75 difficulty, meaning, no students got them correct.

Pilot Study

As the next step, the researcher conducted a pilot study prior to conducting the main experiment in order to refine the treatments. The pilot study had 10 subjects per treatment and was conducted over a period of two days. The researcher ran an analysis of variance to confirm the treatment's strengths. A significant difference between the control and the two treatment groups occurred (see Table 5). Since the ANOVA results were significant (see Table 5), it can be concluded that the treatments had enough strength to produce significance in a larger sample. The pilot study confirmed the validity and strength of the independent variables (see table 4).

Table 4

Descriptive Statistics of All Scores for All Groups – Total Score – Pilot Test

Type	Count	Mean	Standard Deviation
Control Group	10	12.80	5.03
Treatment Group 1	10	26.00	5.54
Treatment Group 2	10	25.90	4.81

Table 5

One-Way ANOVA of Total Scores – Pilot Test

Type	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1152.867	2	576.433	21.844	.000
Within Groups	712.500	27	26.389		
Total	1865.367	29			

The Study Design, Variables, and Statistics

There was one independent variable with two levels, which was Audio and Audio with Mnemonics, and one dependent variable with three levels which was control group, treatment group 1 and treatment group 2, making it a 1x1-design post-test only study. The researcher chose a post-test design to reduce the margin of error possible in a pre-post test format as the pre-test might serve as an advanced organizer for the post-test, increasing the risk of type II error. A one-way ANOVA was used to compare the differences between the treatment groups on two criterion measures. The alpha level was set as p=0.05. The researcher used SPSS (V22) to analyze the data and generate graphics for the illustration of analysis.

Recruitment of Subjects

The researcher requested the support of faculty members from the college of business in recruiting subjects, since the focus of the study was centered on business majors only. The researcher sent an email to faculty members who taught a business course to students who had declared a business major. The email was sent to students asking them to participate in an experiment that would help collect data about learning strategies. If students agreed, the researcher provided a brief description of the study, the estimated time it would require, and how they could participate, including the option to leave the experiment at any time. Students, who chose not to participate were not penalized and received the option for an alternative bonus assignment. Students who agreed to participate in the research study signed a consent form and chose a suitable time from the schedule developed for the experiment.

Data Analysis Procedures: ANOVA, Alpha Level, Power Analysis

Power, by definition, is the ability to find a statistically significant difference when the null hypothesis is in fact false. In other words, power is your ability to find a difference when a real difference exists (“Power Analysis, n.d.”). The power of a study is determined by three factors: the sample size, the alpha level, and the effect size (“Research Consultation,” 2008). A power analysis was conducted to determine the number of participants needed in this study (Cohen, 1988). The alpha level for the ANOVA was set at .05. To achieve power of .80 and a medium effect size ($f^2 = .35$), a total sample size of 159 is required to detect a significant model.

A one-way ANOVA was used to compare the differences between the treatment groups on two criterion measures.

Power analysis using R software for one-way ANOVA showed the following results: N=55 for the medium effect size and the power of .8, while large effect size required N=24 and a power of .8.

The reference for the formula is Cohen's (1988) *Statistical Power Analysis for the Behavioral Sciences*. R code and calculations are:

Table 6

Power Analysis to determine sample size

Effect Size	k	n	f	Sig.level	Power
Large	3	24	0.4	0.05	0.8
Medium	3	55	0.25	0.05	0.8

k=number of groups, n=sample size in each group, f=effect size.

Based on the above calculations, in order to have a statistically significant effect, the experiment needed to recruit a minimum of 55 subjects per group for the experiment. The final experiment exceeded this sample size, as there were 69 subjects per group.

Sample

A sample of Indiana University of Pennsylvania (IUP) undergraduate business students participated in this research study. There were 69 subjects per group totaling 207 subjects. The researcher drew students from IUP business classes and randomly assigned them to a control group or one of two different treatment groups. The subjects had very little prior knowledge about the parts and functionalities of the human lung. Students who participated in this research study received bonus points for their participation.

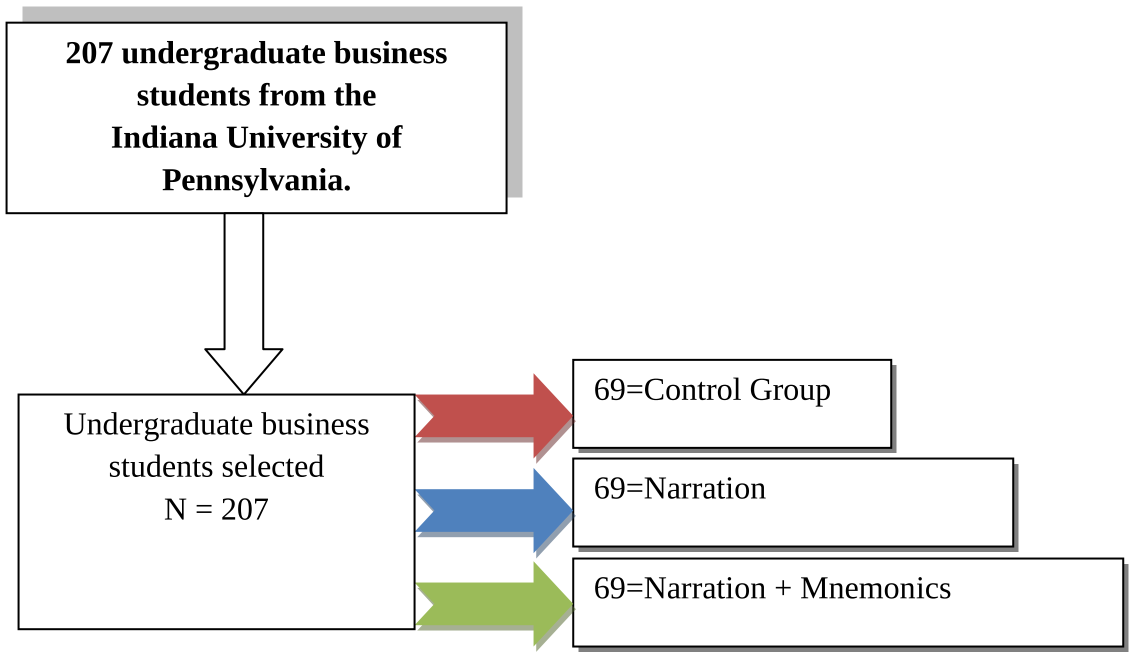

Figure 1. Visual guide of subject assignment to groups

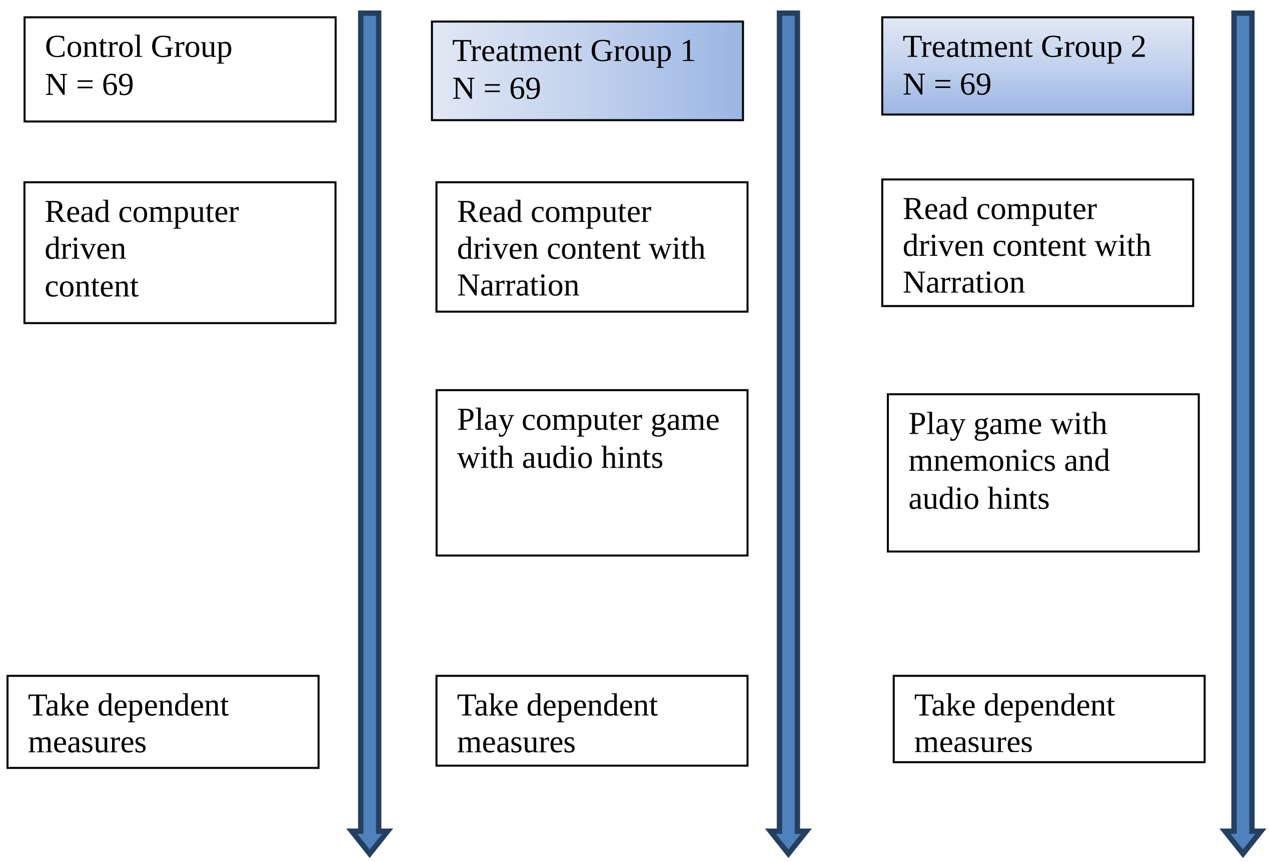

Figure 2. Experiment visual guide

Research Design

The researcher conducted an experimental design study to collect data on the use of audio and mnemonics within a gaming environment on the achievement of conceptual and procedural knowledge among undergraduate business students at IUP. Learning strategies in a gaming environment was the independent variable with two levels: audio (narration) and audio with mnemonics. Achievement of different educational outcomes (conceptual and procedural knowledge scores) was the dependent variable. A prior item analysis identified questions with item difficulty of .75 or less. The researcher conducted a pilot study involving ten subjects to test the strength of the treatments.

There was one independent variable with two levels (audio and audio with mnemonics) and one dependent variable with three levels (CG, TG1, and TG2). The independent variable was learning strategy in a gaming environment. The dependent variable was total score for both criterion tests (conceptual and procedural knowledge). The alpha level was set to $p=0.05$. A one-way ANOVA served as the statistical test in this research study.

In the experiment, each group received content regarding the parts and functionalities of the human lung via an electronic instructional module (see Figures 1 and 2). The Control Group received only text as it traditionally appears in textbooks. Treatment Group 1 received identical content with concurrent audio (narration) in a gaming environment. Treatment Group 2 received identical content with audio (narration) as well as mnemonic hints in a gaming environment. The electronic instructional module was identical for all groups (CG, TG1, and TG2). However, “The Casino Lung” game differed among groups. The control group (CG) did not receive any learning support. Treatment Group 1 (TG1) received audio narration support wherein a female reader concurrently narrated the content to the subject while the system displayed the content on the screen. Treatment Group 2 (TG2) received the same concurrent audio narration with mnemonic hints to accompany the flow of the content on the screen. Mnemonic hints appeared after every practice question to help reinforce the right answers. They then played a game relating to the parts and functions of the human lung (Almeida, 2008), and immediately afterwards, took two criterion tests related to the content. The researcher analyzed the data using SPSS (V22). A pilot study assisted in refining the experiment and an item analysis helped identify and remove weaker questions. The test lasted approximately one hour. The test was administered on a Microsoft Windows-based computer in the computer lab of the Eberly College of Business on the campus of IUP.

Game Environment

The gaming environment was similar to a common casino game called Blackjack. The player was offered three choices of dollar amounts and had to pick one. If the answer was right the dollar amount was incremented based on the amount bet and if the answer was wrong the dollar amount was decremented based on the amount bet from the total score. Below is an example of The Casino Lung Game screen. Figure 3 is the opening screen of the game and illustrates the nature of the game to be played, i.e. Card game – Blackjack. See Figure 3.

Figure 3. The gaming environment

Every subject had to agree to a consent form demonstrating that the subject understood the nature of the study and was willing to participate voluntarily in the study. See Figure 4.

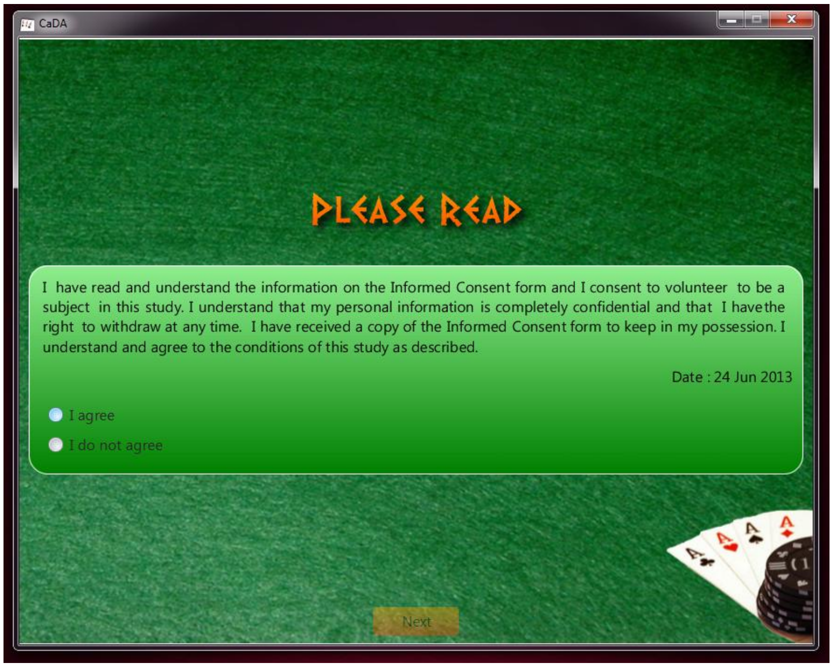

Figure 4. Consent form prior to initiating the experiment

The system asked the subject to fill out a list of items that contained standard demographic information such as age, gender, GPA as shown in Figure 5.

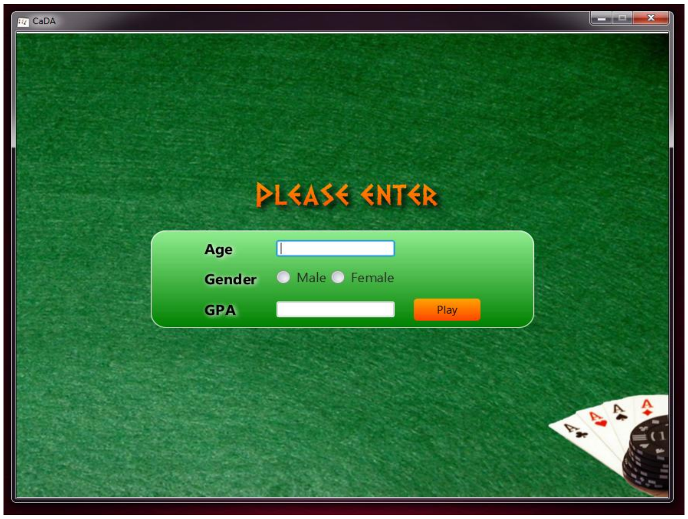

Figure 5. Demographic data

After the subject finished responding to all the demographic questions, the system initiated the gaming environment with some elementary instructions, as seen below in figure 6. The subject was asked to pay attention to the narrators' voice as they read the content. The content was also scrolled across the screen as the narration continued until the end of the content.

Figure 6. Start of treatment group 1

Figure 7 shows an example of an item from the follow-up quiz.. See Figure 7.

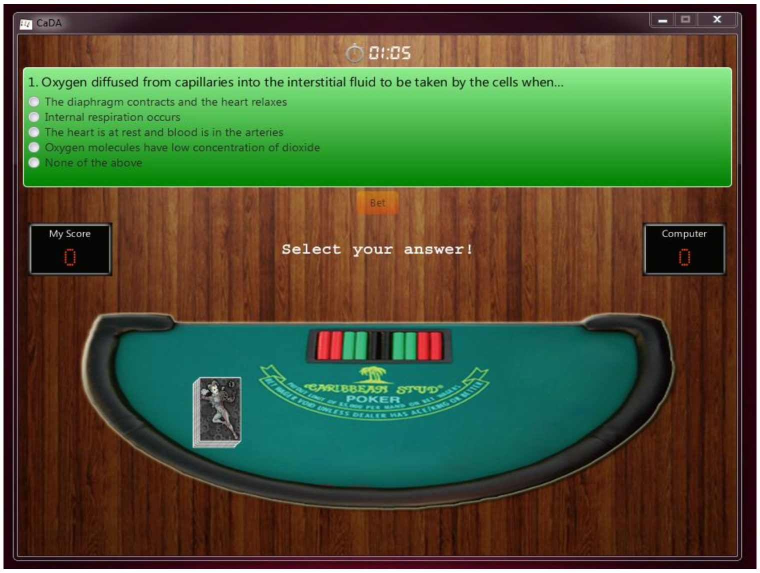

Figure 7. Treatment group 1 quiz

Experimental Procedures

The experiment took place in three computer labs at the main campus at IUP over a period of three days. The researcher established three sessions from which subjects could choose. The sessions were in the morning (9-10 a.m.), afternoon (1-2 p.m.) and evening (6-7 p.m.). The participants had the option to decide when to participate in the research study. When the students came to the lab, they could pick any computer in the lab. The experiment began after they initiated it by touching any key on the keyboard and agreeing to the consent form.

The researcher instructed the subjects to start the experiment when ready. All subjects read the electronic instructional module that contained the content about the parts and functions of the human lung. After subjects finished listening to the content, they were asked by the pre-recorded voice in the gaming environment if they were ready to take a practice test. On agreeing, they were presented with a screen that looked like the illustration in figure 7. The system presented one question at a time along with five possible responses. After subjects chose an answer, they placed a bet on their response. If the response was correct, they won the value of the bet and their total scores were incremented by the value of the bet. If they answered incorrectly, the system deducted the value of their bet from their total scores. Then, subjects took two, twenty-question criterion tests. The criterion tests were conceptual and procedural. There was no minimum time requirement or maximum time limit imposed on the activity. The proctor ensured that there were no disturbances during the research study.

On the day of the experiment, subjects signed in on the computer. After subjects logged in, they received a computer generated, randomly assigned seat as CG, TG1, or TG2. After the experiment was completed, subjects ended the game and exited the lab. The gaming software automatically collected all the data needed for the experiment. The researcher removed all incomplete data prior to the final analysis.

Both the control and treatment groups received an electronic instructional module. Almeida (2008) created the content for the electronic instructional module; it contained information about the parts and functionalities of the human lung. The researcher designed the game and the online skin using Adobe Photoshop and Macromedia Flash 8 Professional. Students, in the CG saw only textual content on the display followed by two, twenty-question criterion tests. Students in TG1 and TG2 saw the same content, accompanied by audio (narration of the text) for both groups and mnemonics for TG2. The control group did not receive audio or audio with mnemonic support. Once TG1 and TG2 subjects received the content, the system prompted them to hit the "Next" button to enter the practice session. During the practice session, subjects received random questions about the content. After they read each question, subjects were to bet one of three possible amounts of fake money in the gaming environment: $10, $50, or $100. Each correct answer incrementally added to the amount accumulated, based on the amount bet, with an incorrect response resulting in the loss of the amount bet. After the practice session was over both groups received two twenty-question criterion-based tests.

Chapter Summary

This chapter describes the process by which subjects were found, recruited and tested for the main study of this experiment. The materials were adapted and ported to a gaming environment for the experiment. An item analysis was used to eliminate questions that were general knowledge and may skew the results. In addition, a pilot study helped to assess the viability of the procedures. The chapter also explained the main study, research design, experimental procedures and data analysis methods that were used to validate and confirm the findings of the study.

The independent factor was learning strategies in a gaming environment with two levels, Narration (Audio) and Narration with Mnemonics. The dependent variable was a total composite score, with three levels: Control Group, which did not receive any learning strategy treatment; Treatment Group 1, which received concurrent audio (narration) as a learning strategy; and Treatment Group 2, which received concurrent audio and mnemonics as the learning strategy. All three groups received identical content on the functioning of a lung. In the CG, subjects read the content and on completion, take two, twenty-question criterion tests that contained twenty PKT questions and twenty CKT questions. Subjects were randomly assigned to participate in one of the three groups. The researcher ran descriptive statistics on each group to determine any statistically significant difference between the means.

CHAPTER 4

DATA ANALYSIS & RESULTS

This chapter provides a summary of the analysis set forth by the research questions in the study. It also provides a detailed description and analysis of the statistical procedures and their results. The data analysis emerged from the data collected from 207 participants. The researcher entered scores for all dependent measures in Excel and SPSS (V22) to verify and validate accuracy. The purpose of the study was to test and quantify if there was a statistically significant difference in outcomes between three groups, where one group received no learning support and the other two groups received different types of learning support in a gaming environment. This chapter reports the results of the data analysis and research questions presented by the researcher in chapter one.

Briefing of the Data

The lung-model used for this study was evaluated and ported from a paper-based format to an electronic gaming format. A pilot study confirmed the strength of the treatments for the Audio and Audio with Mnemonic groups enhancing the quality of the experiment. Weak questions were removed based on an item analysis of questions that were easily answered without prior knowledge of the content. For the two criterion tests, i.e. Procedural and Conceptual, all data was collected electronically and imported into MS Excel. Once all the data was unified into one sheet in MS Excel, the data was exported into SPSS V22 for analysis.

Of the 240 participants recruited to participate in the research study, 207 participants (86%) reported to and completed the lab sessions; 33 participants did not report for the study.

Demographic Data

Demographic data collected from the subjects showed no significant statistical difference for gender, age, gpa and class across the three groups. Subjects in the control, treatment 1, and treatment 2 groups were all similar. Gender mix across groups was almost identical. See Table 7.

Table 7

Frequency results for Demographic Type – Gender

Category	Male	Female
Control Group	40	29
Treatment Group 1	41	28
Treatment Group 2	44	25

The majority of the students in all three groups belonged to the age groups of 19, 20, 21, 22 and 23. See Table 8.

Table 8

Frequency results for Demographic Type – Age

Category	Control Group	Treatment Group 1	Treatment Group 2
Age 19	4	6	10
Age 20	18	15	20
Age 21	30	24	20
Age 22	8	13	13
Age 23	4	5	1

GPA was evenly distributed between 2.1-3 and 3.1- 4 for all three groups. See Table 9.

Table 9

Frequency results for Demographic Type – GPA

Category	Between	2.1 to 3.0	3.1 to 4.0
Control Group		25	44
Treatment Group 1		28	41
Treatment Group 2		20	49

Since, they were business majors, most students were in their third and fourth year of school. See Table 10.

Table 10

Frequency results for Demographic Type – Year

Category	Year 2	Year 3	Year 4
Control Group	6	35	28
Treatment Group 1	7	27	34
Treatment Group 2	9	29	31

The distribution of gender, age, gpa and class was similar and close to identical for all three groups. The possibility of bias due to any of the above categories thus appears limited and the differences in composition are not statistically insignificant. See Table 11.

Table 11

One-Way ANOVA Results for Demographic Type – All Items

Category	N	Mean Sq	F	Sig
Gender	207	0.32	0.48	.489
Age	207	0.90	1.39	.175
GPA	207	0.53	0.79	.375
Year	207	0.47	0.30	.721

Statistical significance for all four categories in the three treatment groups exceeds p=.05 and is therefore considered insignificant. The above results imply that the student samples were similar to each other in all three groups and belonged together as a sample size. Descriptive statistics of all four categories divided into three groups separated from each other for a detailed description is shown below. See Table 12.

Table 12

Descriptive Statistics of all three groups for demographic data

Type			Gender	Age	GPA	Year
1	N	Valid	69	69	69	69
		Missing	0	0	0	0
	Mean		1.42	21.16	3.64	3.32
	Std. Deviation		.497	1.511	.484	.630
	Variance		.247	2.283	.234	.397
2	N	Valid	69	69	69	69
		Missing	0	0	0	0
	Mean		1.41	21.61	3.59	3.36
	Std. Deviation		.495	2.840	.495	.727
	Variance		.245	8.065	.245	.529
3	N	Valid	69	69	69	69
		Missing	0	0	0	0
	Mean		1.36	21.03	3.71	3.32
	Std. Deviation		.484	1.863	.457	.696
	Variance		.234	3.470	.209	.485

A Note Concerning ANOVA

Given one independent variable with two levels and one dependent measure with three levels, the researcher decided to utilize an ANOVA as the statistical analysis of choice. After data collection was completed, the researcher verified the following assumptions to justify the use of ANOVA: levels of measurement, independence, homogeneity of variance, random sampling, and normal distribution. See Appendix E.

Scheffe post-hoc tests were conducted utilizing SPSS to ensure that significant differences were not missed among the treatments. The test also helps to control type-1 error, which reduces the chances of wrongly accepting differences between means as significant.

Descriptive Statistical Data and Hypothesis Test

The latest available version of SPSS (version 22.0) was used for all data analysis. The following assumptions for ANOVA were first verified and satisfied (Field, 2006; Isaac & Michael, 1974; Pallant, 2005) before further analysis was conducted:

1. Levels of Measurement – All dependent measures were scored and analyzed as continuous interval/ratio data, thus this assumption was satisfied.
2. Independent Observations – Each subject completed the instructional modules once at a dedicated personal computer in the controlled environment of a dedicated computer lab.
3. Homogeneity of Variance – The assumption that the variance of the groups was approximately equal was verified using SPSS V22 and the Levene's test for equality of variance. All comparisons successfully passed the Levene's statistic. See Table 13.

Table 13

Test of Homogeneity of Variances

Levene's Statistic	df1	df2	Sig
1.359	2	204	.259

4. Random Sampling – As part of the design requirements, this study utilized a simple random assignment as part of research procedures. Every subject had the same chance of being in any of the three groups. As seen in table 11 above, there were no significant differences between groups for any of the major demographic variables.

5. Normal Distribution – The statistical analysis and exploration with SPSS V22 examined the skewness and kurtosis of the data and verified that the groups did have relatively normal distributions. See Table 14.

Table 14

Normal Distribution of the Dependent Variable

Treatment Groups	Skew /	Std.error =	Z Value	Kurtosis /	Std.error =	Z value
Control Group	-.354	.289	-1.22	-.579	.570	-1.01
Treatment Group 1	-.445	.289	-1.53	-.118	.570	-0.20
Treatment Group 2	-.330	.289	-1.14	-.207	.570	0.36

The researcher randomly assigned questions from a question bank, which was a subset of the questions every subject received during the final test. An item analysis helped remove questions that were easy to answer. Treatment Group 1 received audio only support and the Treatment Group 2 received audio and mnemonic support.

After practicing in a gaming environment, subjects received all forty questions as listed in the instrument that consisted of CKT and PKT. If subjects in the treatment groups scored higher in the final test based on the support, the researcher concluded that the gaming environment along with additional support did have a positive impact on comprehension and recollection. Determination of the extent of the effect has been a goal of this study.

Step 1 - Item Analysis

The first step was to do an item analysis to evaluate the strength of the questions. The researcher selected sixty-three business students to become subjects in the experiment. (See Appendix D)

The researcher performed an item analysis on two categories of test questions, those of the CKT and the PKT. There were twenty questions each per category. Listed in the appendices are results of the item analysis.

Step 2 - Pilot Study

Following the item analysis, the researcher conducted a pilot study in order to refine the treatments of this dissertation. The pilot study had 10 subjects per treatment totaling 30 students. The preliminary results of the pilot study indicated that a main effect of gaming on educational outcomes between the three groups $F(2, 27)=21.844$, $p=<.0005$ occurred. Since the ANOVA was statistically significant ($p=<.0001$), it can be concluded that the treatments had enough strength to find significance in a larger study. Although high standard deviation scores occurred, the pilot indicated that a significant difference existed in test mean scores among the subjects and groups. As seen in Table 15 and 16, $F(2,27) = 21.844$, $p < .0005$ was the result of adequately designed treatments able to generate a significant difference between groups. Means and standard deviations were also calculated.

Table 15

Mean and Standard Deviation – All Items

Group	Procedural			Conceptual		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Control Group	10	6.10	2.81	10	6.70	2.87
Audio	10	14.20	3.43	10	11.80	2.53
Audio + Mnemonics	10	13.90	2.73	10	12.00	2.54

Table 16

One-Way ANOVA Results for Treatment Type – All Items - Pilot

Treatment	N	Mean	S.D.	F	P
Control	10	12.80	5.03	21.844	.000
Audio	10	26.00	5.54		
Audio + Mnemonics	10	25.90	4.82		

The Main Study

The following text describes the results of both hypotheses along with their respective item analysis. Both levels of the independent variable are explained.

Test of Null Hypothesis One

H_o 1: There will be no significant difference in subject achievement on criterion tests between independent variables: Audio and Audio with mnemonics.

Analysis of All Items

The first hypothesis tested the effect of the two levels of the independent variable, i.e. Audio (Narration) and Audio (Narration) with Mnemonics and their effect on achievement. Test of this hypothesis allowed the researcher to investigate the possibility of one learning strategy having a stronger effect than the other one.

ANOVA results from SPSS V22 did not find any significant differences between the two treatments on the two independent measures in the study. Table 17 and Table 18 display the results of the ANOVA results. The results indicated that the audio treatment group (M = 13.87, SD = 2.89) and the audio and mnemonics treatment group (M = 13.42, SD = 2.60) were not statistically significant for the targeted procedural items (F=118.192, df=2, p=.646). The results indicated that the audio treatment group (M = 11.83, 2.29) and the audio and mnemonics treatment group (M = 12.57, 2.34) were not statistically significant for the targeted conceptual items (F=141.490, df=2, p=.182). The mean scores showed subjects performed slightly better in the procedural quiz compared to the conceptual quiz for both independent variables, implying the learning strategy probably suited procedural content more than the conceptual content. See Table 17 and 18.

Table 17

One-Way ANOVA Results for Treatment Type – All Items – Procedural

Treatment	N	Mean	S.D.	F	P
Procedural				118.193	.646
Audio	69	13.87	2.89		
Audio + Mnemonics	69	13.42	2.60		

Table 18

One-Way ANOVA Results for Treatment Type – All Items – Conceptual

Treatment	N	Mean	S.D.	F	P
Conceptual				141.490	.182
Audio	69	11.83	2.29		
Audio Mnemonics	69	12.57	2.34		

Analysis using the Scheffe post-hoc Procedural criterion test for significance indicated that the mean increase between the audio treatment group (M = 13.87, SD = 2.89) to the audio with mnemonics treatment group (M = 13.42, SD = 2.60) a mean increase of 0.45, 95% CI [-.74,1.63], was not statistically significant (p=.65). See Table 19 and 20.

Table 19

Post-Hoc Scheffe Method – All Items (Procedural)

Dependent Variable	(I) Modality	(J) Modality	Mean diff	Sig.
Procedural	Control	Audio	-6.61	.000
		Audio Mnemonics	-6.12	.000
	Audio	Control	6.61	.000
		Audio Mnemonics	.45	.65
	Audio Mnemonics	Control	6.16	.000
		Audio	-.45	.65

Analysis using the Scheffe post-hoc Conceptual criterion test for significance indicated that the mean increase between the audio treatment group (M = 11.83, SD = 2.29) to the audio with mnemonics treatment group (M = 12.57, SD = 2.34) a mean increase of -0.74, 95% CI [-1.72, 0.24], was not statistically significant (p=.18). See Table 19 and 20.

Table 20

Post-Hoc Scheffe Method – All Items (Conceptual)

Dependent Variable	(I) Modality	(J) Modality	Mean diff	Sig.
Conceptual	Control	Audio	-5.41	.000
		Audio Mnemonics	-6.15	.000
	Audio	Control	5.41	.000
		Audio Mnemonics	-.74	.18
	Audio Mnemonics	Control	6.15	.000
		Audio	.74	.18

Test of Null Hypothesis Two

Ho 2: There will be no significant difference in subject achievement on criterion tests between treatment groups and the control group.

There was a significant difference in means between the treatments (Audio M= 25.70, SD= 4.35; Audio + Mnemonics M= 25.99, SD= 3.86) and the control group (M= 13.68, SD= 4.40) on conceptual and procedural knowledge at the p=0.5 level. ANOVA and Scheffe results also showed statistically significant differences between and among the treatments and the control group (F= 191.7, P=.000). Interestingly, there were no statistically significant results between the two treatments themselves i.e. TG1 and TG2, see Table 21.

Table 21

One-Way ANOVA Results for Treatment Type – All Items

Treatment	N	Mean	S.D.	F	P
Control	69	13.68	4.40	191.792	.000
Audio (TG1)	69	25.70	4.35		
Audio + Mnemonics (TG2)	69	25.99	3.86		

In order to see if a significant different existed between the treatments, the researcher ran a post-hoc test with a Scheffe method for significance. No statistical significant results occurred on the criterion tests at the p=.05 level (p= .92 Audio; p= .92 Audio + Mnemonics). See Table 22. However, the differences between control and treatment groups are affirmed.

Table 22

Post-Hoc Scheffe Method – All Items

Dependent Variable	(I) Modality	(J) Modality	Mean diff	Sig.
Criterion Tests	Control	Audio	-12.01	.000
		Audio Mnemonics	-12.30	.000
	Audio	Control	12.01	.000
		Audio Mnemonics	-.29	.92
	Audio Mnemonics	Control	12.30	.000
		Audio	-.29	.92

Chapter Summary

This chapter provided a summary of the analysis as well as the statistical results of this dissertation. It also provided the statistical procedures and their results. The researcher conducted a pilot study in order to refine the treatments of this dissertation. The pilot study had 10 subjects per treatment totaling 30 students. The purpose of the study was to test and quantify if there was a statistically significant difference in achievement scores between the control and treatment groups, Audio and Audio with Mnemonics. The researcher found significant differences between the control and treatment groups in both conceptual and procedural knowledge within a 2D game environment. This research study consisted of 207 randomly assigned subjects. The results showed that hypothesis one was accepted and hypothesis two was rejected. A post-hoc test (Scheffe method) was used to determine additional statistical significances but no statistical significances were found.

CHAPTER 5

DISCUSSION AND CONCLUSION

Briefing of the Data

This study has found that a gaming environment can assist subjects in learning conceptual knowledge. When educators embed elements of inquiry, research, and problem-solving skills, into a gaming environment the result can be enhanced comprehension and retention. With multiple-choice testing and mechanical instruction methods, there is growing concern that students are not learning to solve problems as much as they are mastering memorization of isolated facts to answer test questions.

Gaming environments are engaging and they offer great potential for learning, as found in this study. The elements that comprise this type of game relate to a number of contemporary pedagogic theories. Gaming is a constructivist-learning environment in that it meets the three basic precepts of constructivism (Savery & Duffy, 1995).The precepts involve individuals constructing their own understanding of the game environment, yet providing a stimulus for puzzle solving and supporting social collaboration. There are also clear links with educational theories such as problem-based learning (Boud & Feletti, 1991) and experiential learning (Kolb, 1984). By actively engaging in the game, players solve authentic problems in context and directly experience knowledge acquisition.

This current study developed instruction interventions, specifically audio (narration) and mnemonic learning aids to examine the efficacy of achieving conceptual and procedural knowledge in a gaming environment. The study endeavored to answer the question of whether well-established traditional learning strategies could be more meaningful and help users enhance their learning through an interactive learning experience as seen in a gaming environment.

Based on multimedia dual coding theory, video with adequate verbal support is more effective in assisting subjects' cognition. The findings showed that subjects in the instructional screen cast with narration treatment obtained better mean scores than subjects in the instructional screen cast without narration strategy. The terms verbal redundancy and redundant audio describe multimedia presentations that allow a person to read words while hearing them spoken by a recorded or synthesized voice (Koroghlanian & Klein, 2004; Moreno & Mayer, 2002). Verbal redundancy is a type of bi-sensory stimulus in which the presentation of the same information occurs simultaneously in two sensory modes. This study seemed to advance the theoretical spins of Moreno & Mayer (2000) as the audio treatment surpassed the control group in mean scores. Moreno and Mayer (2002) concluded that the human cognitive system processes bi-sensory redundant stimulus presentations more efficiently that mono-sensory stimuli. This study also concurred with Lewandowski and Kobus (1993). In their study, participants who made category decisions about words presented concurrently in auditory and visual modes recalled more words than did participants who performed the task with words presented in a single mode. This study seemed to advance their scholarship as well.

The Purpose of the Study

Over the past 20 years, educational institutions in general and higher education in particular have spent increasingly larger amounts of time, energy and money to develop and deploy technology with the expectation that it will increase and improve academic achievement. Unfortunately, the return on investment has been poor (lack of academic achievement), instead student performance has been steadily declining (nationally) across all disciplines. Some of this can be attributed to the use of technology as a tool for facilitating teaching rather than a means of improving student learning. Most of the multimedia technologies in the classroom are designed with a content delivery focus. Regardless of how flashy, musical or exciting the media, it has not resulted in improved academic achievement. Adversely, due to the availability of content on several media, students are less keen on attending class because they can easily find the content online. There is also an increased use of publisher designed content that has been pre-packaged for the classroom which has diminished the role of the instructor, into just another form of content delivery.

This study has departed from the customary use of technology to deliver content and has instead focused on use of technology to improve student learning. The use of technology for this study was created to give the student a sense of control, feedback and immersion with the expectation that they will pay greater attention, which will improve comprehension and therefore improve achievement. Technology was not used as a delivery mechanism but instead as a immersion tool, and a means to engage the student's mind more completely.

This study investigated the effects of two instructional strategies in a gaming environment for the achievement of conceptual and procedural knowledge on undergraduate business students at IUP. The two instructional strategies were Audio (Narration) and Mnemonics, applied together or separately. Were they effective in facilitating subject achievement in a gaming environment? Two hundred and seven subjects participated in this research study.

Research Questions

This study sought to answer two research questions:

1. Was there a significant difference in achievement on criterion tests between the two independent variables and

2. Were there significant differences in achievement between the control group and treatment groups?

Summary of the Study

Primary Findings

Composite results of the criterion-based testing for procedural and conceptual knowledge showed that there was a significant difference between the Control Group (CG) and the two treatment groups. Subjects in the CG who did not receive any instructional strategies read plain text and scored under 30% in both tests. Subjects in TG1 and TG2 who received instructional strategies—narration and narration with mnemonics—in a gaming environment performed significantly higher and scored 70% in both tests. It can be concluded that the treatment was effective and that subjects performed significantly higher $F(2, 204, p < 0001) = 191.792$ when content was embedded in a gaming environment.

Subjects who received only audio (narration) in a gaming environment were able to recall significantly more accurate answers compared to the CG. They specifically performed higher in the PKT compared to the CKT. It can be concluded that audio may be specifically better suited as a learning strategy for procedural knowledge content that requires a person to retain information in series to perform a task. The study did not show any significant results when two instructional strategies were embedded in a gaming environment simultaneously. There is evidence to show that similar attempts to integrate more than one learning strategy have yielded insufficient results due to the redundancy principle.

Additional Findings

One may also conclude that as the number of strategies increased, the PKT scores started falling. The difference in scores between CG and TG2 was 59%, compared to CG and TG1, which was 69%. There was only a 2% change in the PKT between TG1 and TG2. As the number of strategies increased, the CKT scores started falling. The difference in scores between CG and TG2 was 63%, compared to CG and TG1, which was 67%. Scores between TG1 and TG2 reversed and subjects scored 4% less in the CKT. Based on the information above, the results showed that there was no significant difference between TG1 and TG2, which implied that the addition of mnemonics to narration did not significantly help the subjects to recall the correct answers. Research on redundancy principle indicates that when the same information is presented in many different forms (narration and text at the same time), this hinders learning (Kalyuga et al., 1999; Mayer et al., 2001).

The results showed there was no significant difference in the total scores between the two independent variables: narration and narration with mnemonics. Scheffes' Post-hoc tests showed a .922, which indicated that there was no statistically significant difference in mean scores between TG1 and TG2. There were some differences between the two criterion tests when comparing the PKT of TG1 (N=69, M=13.87) to TG2 (N=69, M=13.42) and the CKT of TG1(N=69, M=11.82) to TG2 (N=69, M=12.57). However, neither was statistically significant.

There is further support by Samur (2012), who reported that according to the redundancy principle, adding redundant text to multimedia explanation where it is already narrated results in poorer learning (Kalyuga, Chandler, & Sweller, 1999; Mayer et al., 2001). That is, when making a multimedia presentation with a narration and animation, the designers should not add on-screen text that duplicates words that are already spoken in the narration. In this study mnemonic hints were animated as on-screen text to help the subject remember and recall the answer.

Composite results of the criterion-based testing showed that there was a significant impact of the treatment between the CG and the two treatment groups. Subjects in the CG scored significantly lower than the two experiment groups. It can be concluded that the treatment was effective and subjects performed significantly higher $F(2, 204, p < 0001) = 191.792$ when content was embedded in a gaming environment.

Conclusion

In conclusion, when multimedia content is embedded in a gaming environment, it can assist students with learning. Integrating learning strategies helps students comprehend and retain critical content required to score well on a test. Based on the results of this study, content can be embedded in a gaming environment for deeper assimilation and processing. Corporations and several large government organizations have already started adopting gaming in their training materials. These organizations could further leverage their training materials by integrating learning strategies to extend their effectiveness further. These strategies, particularly audio, can also be used in classrooms effectively for students to interact with content and help retain content in long-term memory.

The results also showed that using one learning strategy i.e. Narration (in this study) was more beneficial to the students because they scored significantly higher in the test compared to the control group. Subjects who received two learning strategies at the same time i.e. Narration and Mnemonics did score higher than the control group, but did not score significantly higher than TG1, which received only one learning strategy.

Limitations of study

There are a number of reasons to believe that the results of the study could be inconclusive. Almost 300 students were asked to participate in the study. After several attempts, it became clear that several students were uninterested because they were not science or biology students. Some seemed to be responding to the questions without much thought or very little attention. Though the motivation for such behavior is difficult to quantify, several commented that as business students they were not very interested in anatomy or science. Perhaps, a different population could have resulted in different outcomes.

A part of this study's sample was composed of foreign students whose native language is not English. It was hard for these students to quickly read and understand some of the technical terms found in the lung content. This could have contributed to some of the low scores, particularly in the control group. In addition, students were not very motivated to participate in the experiment. There was a lack of incentive for students to pay attention, as there was no grade associated with the experiment.

Considering the level of gaming today, the level of quality for the experiment may have been discouraging to some participants. Perhaps the resources to build an immersive life-like game that matched real-market games may have produced greater interest. The results could also have been inconclusive because the term "gaming" is often associated with entertainment. Perhaps, students did not do their best or give it the needed attention due to the rudimentary nature of the elements used to construct the treatments, therefore reducing the effectiveness of the experiment.

Recommendations for Future Research

The recommendations for future research stems from the experiences gained from this study. Future research should undertake the following:

1. Examine the effects of these variables with other students. Do similar results hold true for students of other majors?

The results of the studies were promising and demonstrated the benefits of using learning strategies in a gaming environment, however were these results atypical or would students in any discipline perform in the same manner.

2. Explore other types of games that may have a greater impact on students. Blackjack may not invoke enough interest in some students, especially if they have had a bad experience with the game such as losing money at a casino.

   In hindsight, Blackjack may not have been the best choice of game. It is not very popular and may not be directly related to the content. Some students found it lacking in interest and interactivity compared to popular games available today.

3. Examine the effect of time spent on each question and the experiment as a whole.

   Some students were observed clicking through the answers in a very quick or un-thoughtful manner, if every subject was forced to spend a controlled amount of time on every question, the results may be different.

4. Examine possible correlations between visual and aural learning preferences.

   Every learner has a preferred style of learning, some are visual and some could be aural. Depending on a person’s style of learning, a learning strategy may create a bias and skew the results.

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APPENDICES

Appendix A - Instrument - Respiratory System

The main function of the respiratory system is to provide oxygen for the body's cells and remove the carbon dioxide they produce. Oxygen is the most important energy source for the cells. They need it for cellular respiration: the process by which the simple sugar glucose is oxidized (combined with oxygen) to form the energy-rich compound adenosine triphosphate (ATP). The breakdown of more complex carbohydrates produces glucose in cells, including starch, cellulose, and complex sugars such as sucrose (cane or beet sugar) and fructose (fruit sugar). ATP is the compound that all cells use to carry out their ordinary functions: growth, the production of new cell parts and chemicals, and the movement of compounds through cells and the body as a whole.

The mechanical process by which the body takes in oxygen and then releases carbon dioxide is called breathing or pulmonary ventilation. Inhalation (or inspiration) occurs when air flows into the lungs. Exhalation (or expiration) occurs when air flows out of the lungs. A single breath, called a respiratory cycle, consists of an inhalation followed by an exhalation. The actions of the nervous system and the respiratory muscles bring about breathing.

The respiratory muscles are the diaphragm and the intercostal muscles. When the diaphragm (the dome-shaped sheet of muscle beneath the lungs that separates the thoracic chest cavity from the abdominal cavity) contracts, it flattens and moves downward. The intercostal muscles are found between the ribs. When the external intercostal muscles contract, they pull the ribs upward and outward. When the internal intercostal muscles contract, they pull the ribs downward and inward. The actions of all these muscles produce changes in the pressure within the alveoli and the bronchial tree.

Inhalation occurs when motor nerves from the medulla oblongata in the brain carry impulses to the diaphragm and intercostal muscles, stimulating them to contract. When the diaphragm is stimulated to contract, it moves downward. The dome flattens and increases the size of the chest cavity is increased. The external intercostal muscles are also stimulated to contract, and they move the ribs up and outward. This also increases the size of the chest cavity. Since the lungs are attached to the chest (thoracic) walls, as the chest expands, so do the lungs. This action reduces the pressure inside the lungs relative to the pressure of the outside atmospheric air. As a consequence, a partial vacuum is created in the lungs and air rushes in from the outside to fill them. The quantity of fresh air taken in during an inhalation is referred to as tidal air.

The reverse occurs in exhalation. In healthy people, exhalation is mostly a passive process that depends more on the elasticity of the lungs than on muscle contraction. During exhalation, motor nerve stimulation from the brain decreases. The diaphragm relaxes and its dome curves up into the chest cavity, while the external intercostal muscles relax and the ribs move back down and inward. As the chest cavity decreases in size, so do the lungs. The air in the lungs is forced more closely together and its pressure increases. When that pressure rises to a point higher than atmospheric pressure, the air is expelled or forced out of the lungs until the two pressures are equal again.

Under normal circumstances, energy is expended during inhalation, but not during exhalation. However, air can be forcefully expelled, such as during talking, singing, or playing a musical wind instrument. Forced exhalation is an active process that requires muscle contraction. In such a case, the internal intercostal muscles are stimulated to contract, pulling the ribs down and in. This forces more air out of the lungs. The abdominal muscles (rectus abdominis) may also be stimulated to contract, compressing the abdominal organs and pushing the diaphragm upward. This action forces even more air out of the lungs.

A healthy adult at rest breathes in and out-one respiratory cycle-about twelve to sixteen times per minute (children breathe more rapidly, about eighteen to twenty times per minute). Exercise and other factors can change this rate. Total lung capacity is about 12.5 pints (6liters). Under normal circumstances, an individual inhales and exhales about 1pint (475 milliliters) of air in each respiratory cycle. Only about three-quarters of this air reaches the alveoli. The rest of the air remains in the respiratory tract.

Regardless of the volume of air breathed in and out (called the tidal volume), about 2.5 pints (1200 milliliters) remains in the respiratory passageways and alveoli. This amount of air, called the residual volume, keeps the alveoli inflated and allows gas exchange between the lungs and blood vessels to go on continuously.

Once air has filled the lungs, the oxygen in that air must be transported to all the cells in the body. In return, all cells in the body release carbon dioxide that must be transported back to the lungs to be exhaled. The exchanges of gases in the body are known as respiration. External respiration is the exchange of gases through the thin membranes of the alveoli and those of the blood capillaries surrounding them. Internal respiration is the exchange of gases between the blood capillaries and the tissue cells of the body. Within the body, all gases are exchanged through the process of diffusion.

Diffusion is the movement of molecules from an area of greater concentration (existing in greater numbers) to an area of lesser concentration (existing in lesser numbers). Diffusion takes place because molecules have free energy, meaning they are always in motion. This is the case especially with molecules in a gas, which move quicker than those in a solid or liquid. Oxygen and carbon dioxide the gases that pass between the alveoli and their capillaries and between the blood and the interstitial fluid (fluid surrounding cells of the body) move by diffusion.

Internal respiration occurs between the cells in the body and the systemic capillaries (capillaries in the body outside of the lungs). The bond between the oxygen molecules and the iron atoms of hemoglobin is not a very strong or stable one. When red blood cells enter tissues in the body where the concentration of oxygen is low, the bond is readily broken and the oxygen molecules are released. The exchange of gases-oxygen and carbon dioxide-occurs through diffusion.

This occurs when the systemic capillaries pass among the body cells. The blood in the systemic capillaries has a high concentration of oxygen molecules and a low concentration of carbon dioxide molecules. The body cells and the interstitial fluid surrounding them have just the opposite: a low concentration of oxygen molecules and a high concentration of carbon dioxide molecules (because cells use oxygen to create energy, giving off carbon dioxide as the waste product of human metabolism).

Thus, in internal respiration, oxygen diffuses from the capillaries into the interstitial fluid to be taken up by the cells. At the same time, carbon dioxide diffuses from the interstitial fluid into the capillaries. Red blood cells in the now deoxygenated (carrying very little oxygen) blood then transport the carbon dioxide molecules back to the heart through ever larger veins. Finally, the blood returns to the right atrium of the heart via the venae cavae. After flowing into the right ventricle, the deoxygenated blood is pumped through the pulmonary arteries to the lungs, where the cycle of respiration begins once again. Adapted from the World Health Encyclopedia (The Respiratory System, n.d.). See Appendix A for criterion-based questions.

Conceptual Knowledge Test

1. The respiratory muscles are the _____ and _____.
    a) Diaphragm, intercostal muscles
    b) Lungs, diaphragm
    c) Intercostal muscles, chest cavity
    d) Chest, diaphragm
    e) None of the above

2. A single breath is also known as _____.
    a) Exhalation
    b) Breathing
    c) Inhalation
    d) Respiratory cycle
    e) Pulmonary ventilation

3. What is the most important source of energy for cells?
    a) Food
    b) Triphosphate
    c) Sugar glucose
    d) Carbon dioxide
    e) Oxygen

4. Breathing is brought about by the actions of which system?
    a) Respiratory system
    b) Nervous system
    c) Circulatory system
    d) Digestive system
    e) Skeletal muscular system

5. The main function of the respiratory system is to provide oxygen and remove _____.
    a) Mucus
    b) Sugar glucose
    c) ATP
    d) Body impurities
    e) Carbon dioxide

6. The intercostal muscles are found between the ______.
    a) Windpipe

b) Abdominal cavity
c) Bronchial tubes
d) Ribs
e) Alveoli

7. Exhalation is mostly a/an ______.
    a) Passive process
    b) Conscious activity
    c) Unconscious activity
    d) Active process
    e) None of the above

8. Lungs are attached to the ______.
    a) Heart
    b) Thoracic walls
    c) Chest cavity
    d) Windpipe
    e) Diaphragm

9. The quantity of fresh air taken during inhalation is referred to as _____.
    a) Pure air
    b) Tidal air
    c) Chest cavity
    d) Windpipe
    e) Diaphragm

10. Under normal circumstances, _____ is expended during _____.
    a) Energy, exhalation
    b) Inhalation, exhalation
    c) Energy, inhalation
    d) Exhalation, inhalation
    e) None of the above

11. A healthy adult at rest breathes in and out…
    a) 10 to 13 times per minute
    b) 5 to7 times per minute
    c) 20 to 25 times per minute
    d) 12 to 16 times per minute
    e) 18 to 20 times per minute

12. A child breathes in and out…

a) 10 to 13 times per minute
b) 5 to 7 times per minute
c) 20 to 25 times per minute
d) 12 to 16 times per minute
e) 18 to 20 times per minute

13. Individuals inhale ____ of air in each respiratory cycle.

a) 435 milliliters
b) 445 milliliters
c) 455 milliliters
d) 465 milliliters
e) 475 milliliters

14. Residual volume is a type of what?

a) Carbon dioxide
b) Air
c) Mucus
d) Blood vessel
e) Respiratory tract

15. The process by which the body takes oxygen and releases carbon dioxide is called ____.

a) Pulmonary ventilation
b) Thoracic activity
c) Inspiration
d) Expiration
e) None of the above

16. Forced exhalation is an active process that requires _____.

a) Breathing rhythm
b) Abdominal muscles
c) Muscle contraction
d) Oxygen
e) None of the above

17. Total lung capacity is about _______

a. 3 liters
b. 4liters
c. 5 liters
d. 6 1iters

e. 10 liters

18. __is the exchange of gases between the blood capillaries and tissue cells of the body.
    a. External respiration
    b. Internal respiration
    c. External diffusion
    d. Internal diffusion
    e. None of the above

19. Oxygen in the respiratory system is used to _____and form ____.
    a. Burn sugar foods, complex energy
    b. Burn sugars, simple saturators
    c. Burn food, simple sugars
    d. Inform Cilia cells, simple sugars
    e. Inform goblet cells, complex energy

20. What respiratory system part, can't contract on its own?
    a. Diaphragm
    b. Nose
    c. Cilia
    d. Bylia
    e. Lungs

Procedural Knowledge test

1. Oxygen diffuses from capillaries into the interstitial fluid to be taken by the cells when…
    a) The diaphragm contracts and the heart relaxes
    b) Internal respiration occurs
    c) The heart is at rest and blood is in the arteries
    d) Oxygen molecules have low concentration of dioxide
    e) None of the above

2. After carbon dioxide diffuses from interstitial fluid, red blood cells transport carbon dioxide molecules back to the heart through…
    a) Larger veins
    b) Capillaries
    c) Arteries
    d) Triphosphate
    e) Pulmonary ventilation

3. What happens when deoxygenated blood is pumped through the pulmonary arteries back to the lungs?
    a) The cycle of respiration comes to an end
    b) The respiratory cycle begins
    c) Capillaries expand and arteries contract
    d) The heart beats faster
    e) None of the above

4. When the body breaks down complex carbohydrates, which critical respiratory component is generated?
    a) ATP
    b) Oxygen
    c) Cellulose
    d) Glucose
    e) None of the above

5. When the diaphragm contracts, it flattens and _______.
    a) Moves upward
    b) Produces oxygen
    c) Moves downward
    d) Releases carbon dioxide
    e) None of the above

6. When the external intercostal muscles contract, they pull ribs ________.

a) Upward and outward
b) Upward and inward
c) Downward and outward
d) Downward and inward
e) None of the above

7. When the internal costal muscles contract, they pull ribs _______.
   a) Upward and outward
   b) Upward and inward
   c) Downward and outward
   d) Downward and inward
   e) None of the above

8. Intercostal muscles actions produce which type of behavior within the alveoli and the bronchial trees?
   a) Stress
   b) Chest cavity strain
   c) Pressure
   d) Contractions
   e) None of the above

9. The lung is attached to the chest walls. When the chest expands, the lungs…
   a) Contract
   b) Expand
   c) Filter carbon dioxide
   d) Inhale oxygen
   e) None of the above

10. When the diaphragm's dome is flattened, the size of the chest cavity ______.
   a) Decreases
   b) Flattens
   c) Bleeds
   d) Stops
   e) Increases

11. When the chest expands, pressure inside the lungs is ______ relative to the pressure of outside atmospheric air.
   a) Decreased
   b) Increased
   c) Enhanced

d) Brought to zero
e) Not affected

12. When the lungs expand and air rushes in from outside to fill them, (the lungs), what happens as a consequence?
    a) A partial vacuum is reduced
    b) A full vacuum is produced
    c) A half-vacuum is generated
    d) A partial vacuum is released
    e) A partial vacuum is created

13. During exhalation, motor nerve stimulation from the brain _______.
    a) Remains the same
    b) Decreases
    c) Increases
    d) Is activated
    e) Produce rectus abdomens

14. Abdominal muscles, when stimulated to contract, compress the abdominal organs resulting in what?
    a) Pushing the diaphragm upward
    b) Pushing the diaphragm downward
    c) Pushing the lungs upward
    d) Pushing the lungs downward
    e) Nothing

15. What must happen prior to oxygen being transpired to all cells in the body?
    a) Residual volume must be present
    b) No mucus must be present
    c) Air has to be filled in the lungs
    d) Expiration had to be completed
    e) Nothing. At this point, oxygen is already present.

16. When oxygen is low, the bond is readily broken and oxygen molecules are released in the respiratory process, what happens next?
    a) Internal respiration occurs
    b) Abdominal muscles contract
    c) Red blood cells enter tissues
    d) Oxygen is released
    e) None of the above

17. In internal respiration, oxygen diffuses from capillaries into _______.
    a) Interstitial fluid
    b) The blood vessel
    c) Vertebrate embryo
    d) Pulmonary arteries
    e) Larger veins

18. After red blood cells deoxygenates, blood then transports carbon dioxide back to_____.
    a) The lungs
    b) Heart
    c) Diaphragm
    d) Alveoli
    e) The nose

19. When motor nerves from the medulla oblongata in the brain carry impulses to the diaphragm.
    a) Thoracic chest expansion
    b) Internal diffusion occurs
    c) Internal respiration occurs
    d) Inhalation occurs
    e) Intercostal muscles contract

20. Increase in chest cavity is directly affected by the _______.
    a) External intercostal muscles
    b) Internal intercostal muscles
    c) Diaphragm size
    d) The partial vacuum
    e) Alveoli

Revised questions after item analysis:

Included in practice tests for experiment groups, since no questions were removed from the Procedural Knowledge test, all the above questions were retained.

Conceptual Knowledge Test

The research excised Questions 5, 11, 12, 13 and 17 from the conceptual knowledge test.

1. The respiratory muscles are the _____ and _____.
   f) Diaphragm, intercostal muscles
   g) Lungs, diaphragm
   h) Intercostal muscles, chest cavity
   i) Chest, diaphragm
   j) None of the above

2. A single breath is also known as _____.
   f) Exhalation
   g) Breathing
   h) Inhalation
   i) Respiratory cycle
   j) Pulmonary ventilation

3. What is the most important source of energy for cells?
   f) Food
   g) Triphosphate
   h) Sugar glucose
   i) Carbon dioxide
   j) Oxygen

4. Breathing is brought about by the actions of which system?
   f) Respiratory system
   g) Nervous system
   h) Circulatory system
   i) Digestive system
   j) Skeletal muscular system

5. The intercostal muscles are found between the ______.
   f) Windpipe
   g) Abdominal cavity
   h) Bronchial tubes

i) Ribs
j) Alveoli

6. Exhalation is mostly a/an ______.
   f) Passive process
   g) Conscious activity
   h) Unconscious activity
   i) Active process
   j) None of the above

7. Lungs are attached to the ______.
   f) Heart
   g) Thoracic walls
   h) Chest cavity
   i) Windpipe
   j) Diaphragm

8. The quantity of fresh air taken during inhalation is referred to as _____.
   f) Pure air
   g) Tidal air
   h) Chest cavity
   i) Windpipe
   j) Diaphragm

9. Under normal circumstances, _____ is expended during _____.
   f) Energy, exhalation
   g) Inhalation, exhalation
   h) Energy, inhalation
   i) Exhalation, inhalation
   j) None of the above

10. Residual volume is a type of what?
   f) Carbon dioxide
   g) Air
   h) Mucus
   i) Blood vessel
   j) Respiratory tract

11. The process by which the body takes oxygen and releases carbon dioxide is called ____.
   f) Pulmonary ventilation

g) Thoracic activity
h) Inspiration
i) Expiration
j) None of the above

12. Forced exhalation is an active process that requires _____.
    f) Breathing rhythm
    g) Abdominal muscles
    h) Muscle contraction
    i) Oxygen
    j) None of the above

13. __is the exchange of gases between the blood capillaries and tissue cells of the body.
    a. External respiration
    b. Internal respiration
    c. External diffusion
    d. Internal diffusion
    e. None of the above

14. Oxygen in the respiratory system is used to _____and form ____.
    a. Burn sugar foods, complex energy
    b. Burn sugars, simple saturators
    c. Burn food, simple sugars
    d. Inform Cilia cells, simple sugars
    e. Inform goblet cells, complex energy

15. What respiratory system part, can't contract on its own?
    a. Diaphragm
    b. Nose
    c. Cilia
    d. Bylia
    e. Lungs

Appendix B - Professional reference

Dr. Vipul Garg

UPMC East, Emergency Department.

2775 Mosside Boulevard

Monroeville, PA 15146

Dr. Nashat Zuraikat

Professor, Nursing/Allied Health

230 Johnson Hall

Indiana, PA 15705

The quizzes created from the content and used in the experiment were authored by;

Dr. Luis Almeida

Stouffer Hall, Room 121

1175 Maple Street

Indiana, PA 15705

Appendix C - Demographic Survey

The researcher collected demographic data about the participants to find patterns and correlations between the participants and the experiment. The information will be available for analysis in later studies to further narrow the results to a specific group of students. The subjects' gender, age, and GPA, along with major may provide some interesting relationships. The participants' year in school, texting habits, and gaming habits may also provide some interesting correlations with respect to their attitudes towards learning information provided in a gaming environment. Time spent online or with other electronic media may also influence a participant's attitude towards learning in a gaming environment.

Demographic Survey Form

1. What is your gender? (+) Male Female
2. What is your age? ________
3. What is your current GPA? 1.0-2.0 or 2.1-3.0 or 3.1-4.0
4. What is your major: MKT, MGT, ACTG, FIN, MIS, TST.
5. What year of school are you currently in? Freshman, Sophomore, Junior, Senior
6. How many courses have you taken that involved learning the workings of a human lung as part of the curriculum in college?

   0-2, 3-5
7. Do you correspond by text message? If yes, how many do you send per day?

   ____ Less than 100, ____ 100 -500, ____ 500 – 1,000, ____ More than 1,000
8. Are you a gamer? Yes - No.
9. (Only if yes to 8) How many hours per week do you play ____
10. How many hours per day do you use your cell phone for functions other than talking or texting (Facebook/Twitter/email/browsing, etc.)? _____

____ Less than 100, ____ 100 -500, ____ 500 – 1,000, ____ More than 1,000

11. How many hours a day do you surf the web (any device) ____/day

Appendix D - Item Analysis

Table 23

Conceptual Knowledge Test: Item Analysis

St's	C-Q1	C-Q2	C-Q3	C-Q4	C-Q5	C-Q6	C-Q7	C-Q8	C-Q9	C-Q10	C-Q11	C-Q12	C-Q13	C-Q14	C-Q15	C-Q16	C-Q17	C-Q18	C-Q19	C-Q20
1	B	C	C	B	C	E	D	C	B	A	E	C	E	B	A	C	D	C	A	A
2	A	D	C	A	E	B	C	C	E	B	D	C	E	D	C	B	D	B	D	C
3	B	D	E	A	E	D	D	C	D	C	C	C	E	D	C	C	D	C	B	C
4	A	D	E	A	E	D	A	E	B	C	D	E	C	B	A	C	D	D	A	E
5	A	C	C	A	E	D	A	C	B	C	D	E	E	B	A	E	D	D	B	E
6	A	C	E	A	E	D	C	B	B	C	D	E	D	B	D	E	D	D	A	E
7	D	C	E	A	E	C	A	E	B	A	D	E	A	E	A	B	D	D	A	A
8	B	D	C	A	E	D	A	C	B	C	D	E	D	E	A	C	A	C	B	E
9	A	C	E	A	E	D	A	B	A	C	D	E	A	B	E	C	D	D	A	E
10	A	D	E	A	E	D	A	B	B	C	D	E	E	B	A	C	D	B	A	E
11	B	C	D	A	C	D	C	C	B	E	D	E	E	C	A	D	B	A	B	D
13	A	C	C	A	E	B	A	B	B	A	D	E	B	A	A	C	D	D	A	E
14	B	D	E	A	E	D	C	C	B	C	D	E	B	A	C	C	D	C	A	B
15	B	D	E	B	E	E	C	B	B	C	D	E	A	A	A	B	E	B	A	E
16	A	E	E	A	E	D	C	C	B	C	D	E	B	B	A	B	E	D	A	E
17	B	D	B	A	E	B	C	B	A	A	D	E	A	D	D	C	A	D	A	B
18	B	E	E	A	E	B	D	C	A	D	D	C	D	B	A	C	D	D	D	A
19	C	B	B	A	E	D	C	C	B	C	D	C	C	A	D	C	C	B	A	A
20	B	D	E	A	E	D	A	C	A	A	C	D	C	B	A	C	B	B	A	A
21	B	C	C	A	E	D	A	B	B	A	D	E	B	E	D	C	C	B	A	A
22	E	D	C	A	E	D	C	C	A	E	D	E	D	B	E	E	D	E	D	D
23	B	D	E	B	E	D	A	C	B	C	C	D	C	A	A	C	B	B	A	A
24	A	C	E	A	E	C	A	E	B	C	D	C	D	A	A	B	D	D	A	B
25	C	A	B	D	A	D	D	B	B	A	A	E	B	A	C	D	E	B	C	A
26	A	E	E	A	E	D	A	D	A	C	C	E	B	C	B	B	D	D	B	C
27	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
28	B	B	C	A	C	D	A	C	B	C	D	E	D	E	C	C	B	B	A	E
32	D	C	A	A	E	D	C	A	A	E	A	E	A	E	D	D	B	D	A	B
33	E	D	C	A	E	D	C	B	B	A	D	E	D	E	A	C	D	D	C	A
34	A	C	E	A	E	D	A	B	B	C	D	E	A	B	E	C	D	D	C	E
36	A	D	E	A	E	D	A	B	B	C	D	E	E	B	D	C	D	A	E	E
38	A	D	E	A	E	D	C	E	B	C	D	E	D	E	A	B	A	C	A	A
39	B	D	E	A	E	D	D	C	E	C	C	A	C	E	C	C	C	B	A	C
40	A	E	C	A	E	D	C	B	A	C	E	C	D	B	A	C	D	D	A	A
41	B	D	C	A	E	B	D	B	C	C	D	E	E	E	D	D	D	D	A	E
42	A	D	E	A	E	D	A	B	B	C	D	C	B	B	A	B	D	A	B	B
43	A	E	E	B	E	D	A	C	B	C	D	E	C	B	C	C	D	B	A	E
44	B	C	B	A	E	B	A	C	B	C	D	A	D	A	A	B	A	D	A	E
45	B	D	C	A	E	B	C	B	A	B	D	E	E	E	A	C	D	D	A	B
46	C	D	E	C	C	C	B	B	B	C	D	E	E	D	B	C	D	C	B	A
47	C	D	E	A	C	A	D	E	D	C	C	E	D	D	D	D	C	C	B	E
48	A	C	E	B	E	D	A	E	B	C	C	E	A	B	D	C	E	D	C	A
49	D	D	C	A	E	E	C	E	B	C	D	D	A	B	A	C	B	B	A	C
50	B	D	D	A	C	E	B	E	C	C	A	C	A	A	C	B	D	A	A	A
51	A	D	C	A	E	D	A	B	C	C	D	E	B	E	A	C	C	D	A	B
52	B	B	E	A	E	D	D	E	C	B	A	B	C	D	C	C	A	B	A	B
53	A	D	E	A	E	D	C	E	A	A	D	E	E	B	E	C	D	B	E	A
54	A	D	E	A	E	B	A	B	D	D	D	E	D	E	E	A	E	D	B	C
55	B	D	E	A	E	B	A	C	B	C	C	A	D	E	A	C	A	D	E	E
56	B	C	C	A	E	B	A	B	B	A	E	C	E	B	A	C	D	B	B	A

Table 23 (continued)

57	B	D	C	A	E	D	D	C	B	A	D	E	B	E	A	C	B	D	C	C
58	B	E	C	A	E	B	A	C	B	C	D	E	E	B	A	C	D	B	A	C
59	A	D	B	A	E	D	A	B	A	C	D	E	B	A	A	C	D	B	A	A
60	B	C	A	A	E	B	D	B	D	D	A	D	B	A	E	B	B	B	A	A
62	B	D	E	A	E	C	A	B	A	C	D	E	B	E	A	C	D	B	A	C
63	A	D	B	A	E	B	D	E	B	A	D	E	D	D	E	E	A	B	B	B
A	22	1	2	48	1	1	26	1	12	12	5	3	9	11	28	1	7	4	33	18
B	24	3	6	5	0	13	2	22	33	3	0	1	12	20	2	11	8	20	11	9
C	5	16	18	2	7	5	17	21	5	35	9	11	8	3	10	35	6	8	6	10
D	3	30	2	1	0	33	11	1	4	3	39	4	14	7	9	5	30	23	3	2
E	2	6	28	0	48	4	0	11	2	3	3	37	13	15	7	4	5	1	3	17
tot	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
As	A	D	E	B	E	D	A	B	B	C	D	E	E	B	A	C	D	B	C	E

Table 24

Conceptual Knowledge Test: Item Analysis

Raw			Ranked			Grade		Removed
Subjects	Percent		Subjects	Percent				
C-Q1	36%		C-Q5	81%		B		5 passing grade
C-Q2	48%		C-Q11	65%		D		C-Q11 – Numeric
C-Q3	46%		C-Q12	65%		D		C-Q12 – Numeric
C-Q4	7%		C-Q9	58%		F		C-Q13 – Numeric
C-Q5	80%		C-Q10	58%		F		C-Q17 – Numeric
C-Q6	55%		C-Q6	56%		F		
C-Q7	45%		C-Q16	56%		F		A=90-100
C-Q8	39%		C-Q2	48%		F		B=80-89
C-Q9	55%		C-Q17	47%		F		C=70-79
C-Q10	59%		C-Q3	45%		F		D=60-69
C-Q11	66%		C-Q15	45%		F		F=59-0
C-Q12	64%		C-Q7	44%		F		
C-Q13	18%		C-Q1	38%		F		
C-Q14	32%		C-Q8	37%		F		
C-Q15	46%		C-Q18	35%		F		
C-Q16	57%		C-Q14	32%		F		
C-Q17	46%		C-Q20	29%		F		
C-Q18	34%		C-Q13	16%		F		
C-Q19	11%		C-Q19	11%		F		
C-Q20	29%		C-Q4	8%		F		

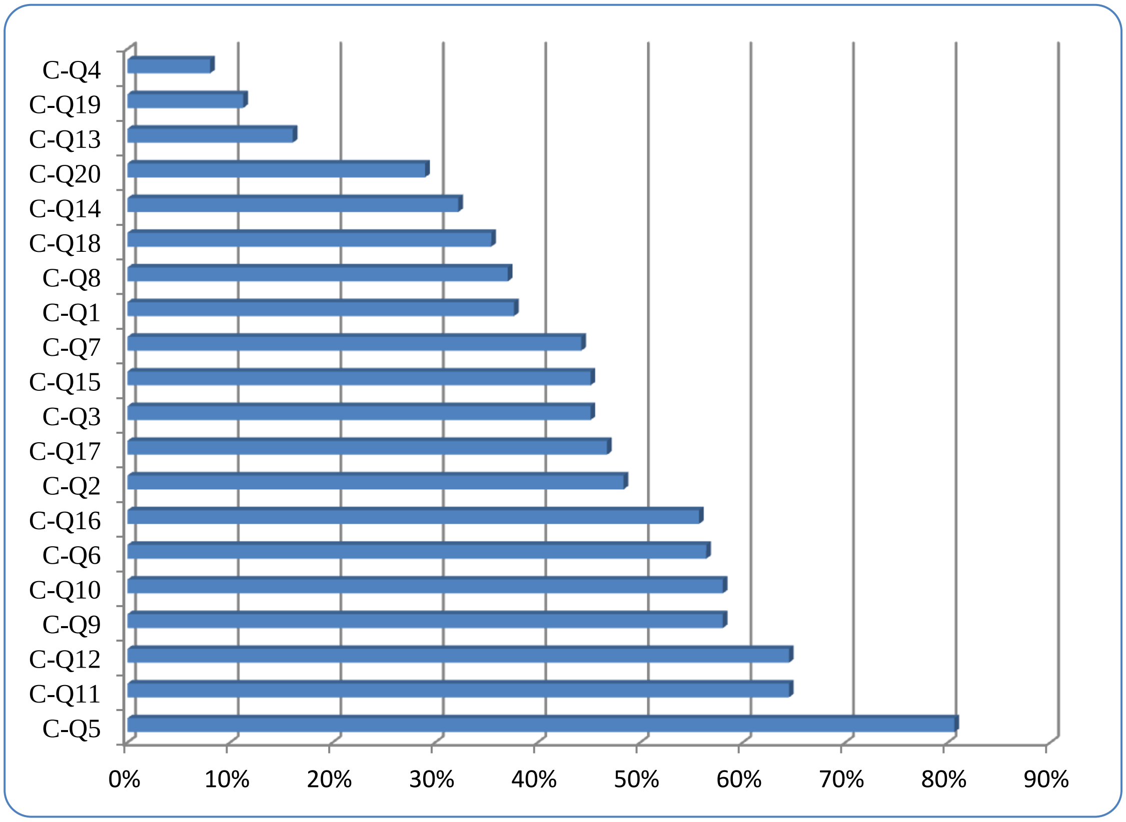

Figure 8. Least to most successful answers: Conceptual knowledge test: Item analysis

Table 25

Procedural knowledge test: Item analysis

St's	R-Q1	R-Q2	R-Q3	R-Q4	R-Q5	R-Q6	R-Q7	R-Q8	R-Q9	R-Q10	R-Q11	R-Q12	R-Q13	R-Q14	R-Q15	R-Q16	R-Q17	R-Q18	R-Q19	R-Q20
1	C	B	B	D	C	C	D	D	D	B	A	E	D	B	C	B	B	D	A	A
2	C	A	C	D	A	A	D	B	B	A	A	E	B	D	C	C	B	A	E	D
3	D	B	B	C	C	A	A	B	C	E	A	D	C	B	A	B	B	C	B	A
4	D	A	B	D	C	D	D	C	B	E	B	B	B	C	A	D	A	B	E	A
5	E	B	B	E	C	A	A	C	D	E	B	E	A	A	C	A	D	B	E	E
6	D	C	B	D	C	A	D	C	D	E	B	C	D	A	A	A	E	A	A	A
7	B	C	B	A	C	D	A	C	B	A	B	B	C	B	C	E	D	B	C	A
8	B	E	A	D	C	A	D	D	B	A	B	E	C	A	C	C	A	D	C	D
9	B	C	B	E	C	D	D	C	B	E	E	E	A	B	C	A	B	A	B	B
10	B	A	B	D	C	A	D	C	B	E	A	A	B	A	E	A	A	A	A	A
11	B	E	D	A	B	A	A	C	B	A	A	E	C	A	C	E	B	D	D	C

13	D	B	C	D	C	A	D	D	B	A	A	E	A	A	D	A	D	A	A	B
14	A	B	A	E	B	A	D	D	D	E	A	E	A	B	D	A	D	A	A	C
15	B	A	B	D	C	A	D	B	D	A	B	E	B	B	A	C	B	B	B	B
16	E	E	B	C	C	A	D	D	D	E	A	A	A	A	C	A	A	A	D	C
17	B	C	C	D	A	D	D	D	B	A	B	E	C	C	D	C	D	A	B	B
18	B	E	B	B	A	B	A	D	D	A	D	B	B	C	D	B	B	B	C	C
19	D	B	B	C	C	A	D	D	D	A	D	B	C	A	C	A	D	A	E	A
20	B	B	D	A	A	D	D	D	B	B	C	B	B	C	C	C	B	A	A	C
21	B	B	B	A	C	D	A	C	B	E	B	C	B	B	C	A	A	A	D	B
22	E	C	A	A	A	D	D	D	B	C	B	E	B	E	A	E	C	D	D	E
23	C	E	A	E	C	A	D	D	B	A	B	E	A	A	D	C	B	A	E	A
24	B	B	B	A	A	A	D	D	B	A	B	E	B	B	C	D	E	A	E	B
25	C	E	B	D	B	B	D	C	A	E	B	D	B	A	C	D	A	B	A	C
26	A	A	B	B	D	A	A	B	B	A	B	C	C	A	D	D	D	B	E	B
27	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
28	B	C	A	D	C	D	D	D	D	B	B	E	B	C	A	A	B	A	D	D
32	C	C	B	D	A	A	D	D	A	E	B	B	B	A	E	A	D	B	A	B
33	B	E	C	D	C	D	D	D	B	A	E	E	D	A	E	A	D	A	B	C
34	B	A	B	A	E	C	B	C	D	A	A	A	B	A	C	A	B	B	B	C
36	B	A	E	E	C	A	D	C	B	E	A	E	B	A	A	C	A	B	A	A
38	D	B	A	D	A	D	A	C	B	A	B	E	C	A	A	C	D	A	E	B
39	D	E	C	D	A	B	C	B	A	C	B	D	C	C	A	B	C	A	C	E
40	B	B	A	B	C	A	D	D	B	B	B	E	C	A	C	A	D	D	E	C
41	B	A	B	D	D	A	C	D	B	E	B	E	D	A	D	A	D	B	C	E
42	D	E	C	C	C	A	D	C	D	E	B	A	B	A	C	A	D	A	C	B
43	E	A	B	E	C	A	D	C	B	E	A	E	B	A	D	E	A	B	D	C
44	B	E	A	D	A	C	A	C	D	A	D	E	C	A	E	A	A	A	B	A
45	B	C	D	B	C	D	A	B	B	B	A	E	B	A	D	A	D	A	E	B
46	D	C	C	D	D	A	D	C	A	B	B	D	D	B	D	B	D	A	A	D
47	D	D	C	A	D	D	A	B	C	E	C	D	C	B	C	A	A	C	B	B
48	D	A	B	D	D	A	C	C	B	A	B	E	A	C	D	A	E	B	D	A
49	B	B	A	D	C	A	D	D	B	E	E	E	A	B	E	C	D	B	D	A
50	A	D	B	D	C	B	D	D	C	A	D	D	E	B	C	A	B	A	B	E
51	A	A	A	D	C	B	B	C	B	A	B	E	B	A	C	A	E	B	B	E
52	D	E	C	B	A	A	D	C	B	A	A	E	C	A	D	A	A	B	D	D
53	E	A	B	D	D	A	D	D	B	A	A	E	A	E	E	C	B	A	C	C
54	A	D	B	A	C	A	C	D	A	A	A	C	E	A	A	C	B	E	D	D
55	D	B	B	D	A	A	D	D	B	A	B	B	B	A	E	E	D	B	E	C
56	A	B	C	D	A	A	D	D	B	A	B	E	B	C	C	C	A	D	B	B
57	D	E	B	D	E	B	B	C	A	E	B	B	C	A	E	A	D	A	C	B
58	B	A	E	A	C	A	D	E	D	A	B	E	A	B	E	B	B	A	A	C
59	B	E	B	B	C	A	D	C	A	A	B	E	C	A	D	A	D	A	A	A
60	D	C	C	A	C	B	A	D	B	A	B	D	B	B	C	D	D	D	B	C
62	B	B	A	A	C	A	D	B	D	B	B	E	B	B	A	B	D	D	D	B
63	B	B	A	E	C	D	A	C	B	E	A	E	B	A	A	A	A	D	C	B
A	6	13	12	12	13	32	13	0	7	27	16	4	10	29	12	26	13	26	12	13
B	24	16	27	6	3	7	3	8	31	7	30	8	23	15	0	7	15	17	12	16

Table 25 (continued)

C	6	11	12	5	32	4	5	23	4	3	3	5	16	9	22	13	3	3	10	15
D	15	3	3	26	6	13	35	24	14	0	4	7	5	1	13	5	21	9	11	6
E	5	13	2	7	2	0	0	1	0	19	3	32	2	2	9	5	4	1	11	6
Total	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Ans	B	B	B	A	A	A	D	C	B	A	A	B	B	A	C	A	A	A	D	A

Table 26

Procedural knowledge test: Item analysis

St's	R-Q1	R-Q2	R-Q3	R-Q4	R-Q5	R-Q6	R-Q7	R-Q8	R-Q9	R-Q10	R-Q11	R-Q12	R-Q13	R-Q14	R-Q15	R-Q16	R-Q17	R-Q18	R-Q19	R-Q20
1	C	B	B	D	C	C	D	D	D	B	A	E	D	B	C	B	B	D	A	A
2	C	A	C	D	A	A	D	B	B	A	A	E	B	D	C	C	B	A	E	D
3	D	B	B	C	C	A	A	B	C	E	A	D	C	B	A	B	B	C	B	A
4	D	A	B	D	C	D	D	C	B	E	B	B	B	C	A	D	A	B	E	A
5	E	B	B	E	C	A	A	C	D	E	B	E	A	A	C	A	D	B	E	E
6	D	C	B	D	C	A	D	C	D	E	B	C	D	A	A	A	E	A	A	A
7	B	C	B	A	C	D	A	C	B	A	B	B	C	B	C	E	D	B	C	A
8	B	E	A	D	C	A	D	D	B	A	B	E	C	A	C	C	A	D	C	D
9	B	C	B	E	C	D	D	C	B	E	E	E	A	B	C	A	B	A	B	B
10	B	A	B	D	C	A	D	C	B	E	A	A	B	A	E	A	A	A	A	A
11	B	E	D	A	B	A	A	C	B	A	A	E	C	A	C	E	B	D	D	C
13	D	B	C	D	C	A	D	D	B	A	A	E	A	A	D	A	D	A	A	B
14	A	B	A	E	B	A	D	D	D	E	A	E	A	B	D	A	D	A	A	C
15	B	A	B	D	C	A	D	B	D	A	B	E	B	B	A	C	B	B	B	B
16	E	E	B	C	C	A	D	D	D	E	A	A	A	A	C	A	A	A	D	C
17	B	C	C	D	A	D	D	D	B	A	B	E	C	C	D	C	D	A	B	B
18	B	E	B	B	A	B	A	D	D	A	D	B	B	C	D	B	B	B	C	C
19	D	B	B	C	C	A	D	D	D	A	D	B	C	A	C	A	D	A	E	A
20	B	B	D	A	A	D	D	D	B	B	C	B	B	C	C	C	B	A	A	C
21	B	B	B	A	C	D	A	C	B	E	B	C	B	B	C	A	A	A	D	B
22	E	C	A	A	A	D	D	D	B	C	B	E	B	E	A	E	C	D	D	E
23	C	E	A	E	C	A	D	D	B	A	B	E	A	A	D	C	B	A	E	A
24	B	B	B	A	A	A	D	D	B	A	B	E	B	B	C	D	E	A	E	B
25	C	E	B	D	B	B	D	C	A	E	B	D	B	A	C	D	A	B	A	C
26	A	A	B	B	D	A	A	B	B	A	B	C	C	A	D	D	D	B	E	B
27	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
28	B	C	A	D	C	D	D	D	D	B	B	E	B	C	A	A	B	A	D	D
32	C	C	B	D	A	A	D	D	A	E	B	B	B	A	E	A	D	B	A	B
33	B	E	C	D	C	D	D	D	B	A	E	E	D	A	E	A	D	A	B	C
34	B	A	B	A	E	C	B	C	D	A	A	A	B	A	C	A	B	B	B	C
36	B	A	E	E	C	A	D	C	B	E	A	E	B	A	A	C	A	B	A	A
38	D	B	A	D	A	D	A	C	B	A	B	E	C	A	A	C	D	A	E	B
39	D	E	C	D	A	B	C	B	A	C	B	D	C	C	A	B	C	A	C	E
40	B	B	A	B	C	A	D	D	B	B	B	E	C	A	C	A	D	D	E	C
41	B	A	B	D	D	A	C	D	B	E	B	E	D	A	D	A	D	B	C	E
42	D	E	C	C	C	A	D	C	D	E	B	A	B	A	C	A	D	A	C	B

43	E	A	B	E	C	A	D	C	B	E	A	E	B	A	D	E	A	B	D	C
44	B	E	A	D	A	C	A	C	D	A	D	E	C	A	E	A	A	A	B	A
45	B	C	D	B	C	D	A	B	B	B	A	E	B	A	D	A	D	A	E	B
46	D	C	C	D	D	A	D	C	A	B	B	D	D	B	D	B	D	A	A	D
47	D	D	C	A	D	D	A	B	C	E	C	D	C	B	C	A	A	C	B	B
48	D	A	B	D	D	A	C	C	B	A	B	E	A	C	D	A	E	B	D	A
49	B	B	A	D	C	A	D	D	B	E	E	E	A	B	E	C	D	B	D	A
50	A	D	B	D	C	B	D	D	C	A	D	D	E	B	C	A	B	A	B	E
51	A	A	A	D	C	B	B	C	B	A	B	E	B	A	C	A	E	B	B	E
52	D	E	C	B	A	A	D	C	B	A	A	E	C	A	D	A	A	B	D	D
53	E	A	B	D	D	A	D	D	B	A	A	E	A	E	E	C	B	A	C	C
54	A	D	B	A	C	A	C	D	A	A	A	C	E	A	A	C	B	E	D	D
55	D	B	B	D	A	A	D	D	B	A	B	B	B	A	E	E	D	B	E	C
56	A	B	C	D	A	A	D	D	B	A	B	E	B	C	C	C	A	D	B	B
57	D	E	B	D	E	B	B	C	A	E	B	B	C	A	E	A	D	A	C	B
58	B	A	E	A	C	A	D	E	D	A	B	E	A	B	E	B	B	A	A	C
59	B	E	B	B	C	A	D	C	A	A	B	E	C	A	D	A	D	A	A	A
60	D	C	C	A	C	B	A	D	B	A	B	D	B	B	C	D	D	D	B	C
62	B	B	A	A	C	A	D	B	D	B	B	E	B	B	A	B	D	D	D	B
63	B	B	A	E	C	D	A	C	B	E	A	E	B	A	A	A	A	D	C	B
A	6	13	12	12	13	32	13	0	7	27	16	4	10	29	12	26	13	26	12	13
B	24	16	27	6	3	7	3	8	31	7	30	8	23	15	0	7	15	17	12	16
C	6	11	12	5	32	4	5	23	4	3	3	5	16	9	22	13	3	3	10	15
D	15	3	3	26	6	13	35	24	14	0	4	7	5	1	13	5	21	9	11	6
E	5	13	2	7	2	0	0	1	0	19	3	32	2	2	9	5	4	1	11	6
Total	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Ans	B	B	B	A	A	A	D	C	B	A	A	B	B	A	C	A	A	A	D	A

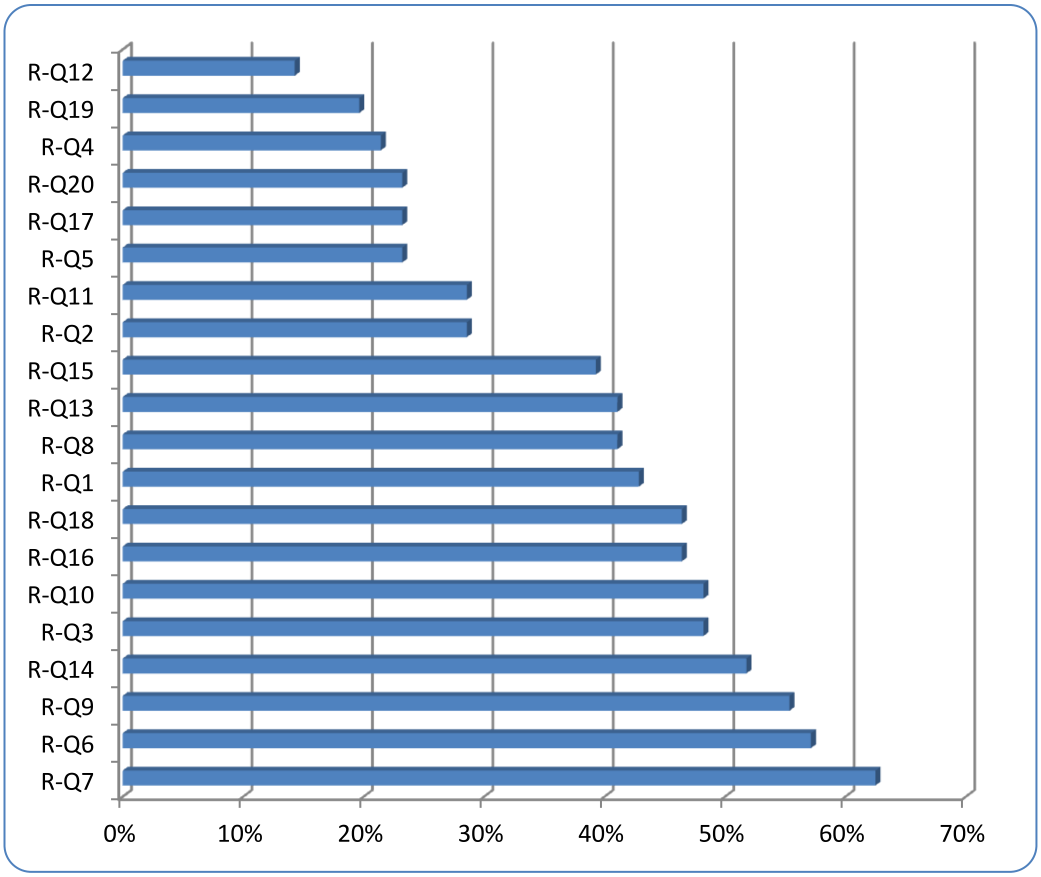

Figure 9. Least to most successful answers: Procedural knowledge test: Item analysis

Appendix E - ANOVA requirements

Table 27

Normal Distribution of the Dependent Variable

Treatment Groups	Skew	/ Std.error	= Z Value	Kurtosis /	Std.error =	Z value
Control Group	-.354	.289	-1.22	-.579	.570	-1.01
Treatment Group 1	-.445	.289	-1.53	-.118	.570	-0.20
Treatment Group 2	-.330	.289	-1.14	-.207	.570	0.36

Table 28

Shapiro-Wilk Test

Group Type Scores	**Statistic**	**df**	**Sig. p value > 0.05**
Control Group	.969	69	.085
Treatment Group 1	.973	69	.144
Treatment Group 2	.983	69	.486

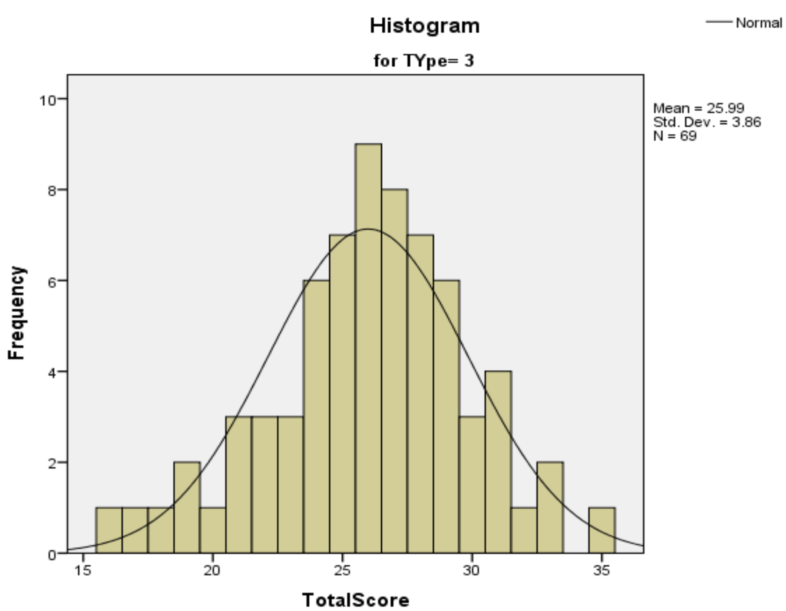

Figure 10. Histogram (Visual indication of normality) for TG2

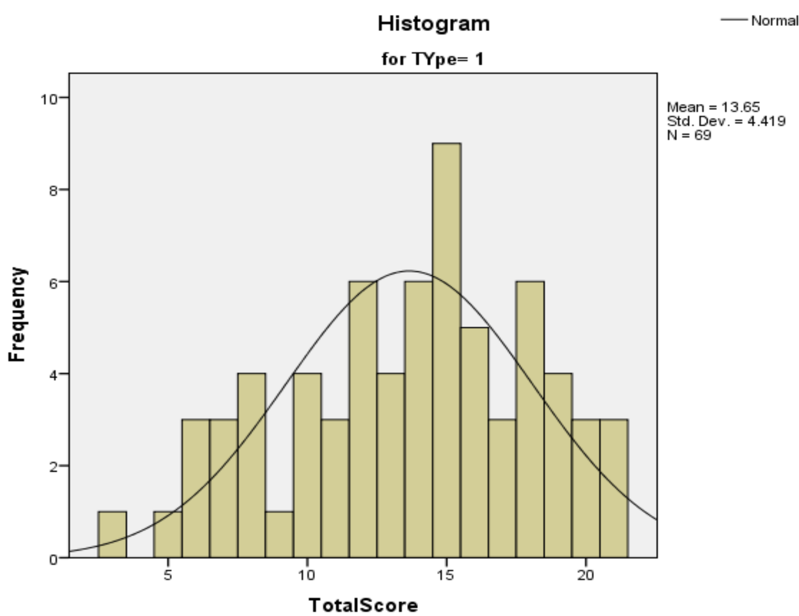

Figure 11. Histogram (Visual indication of normality) for CG

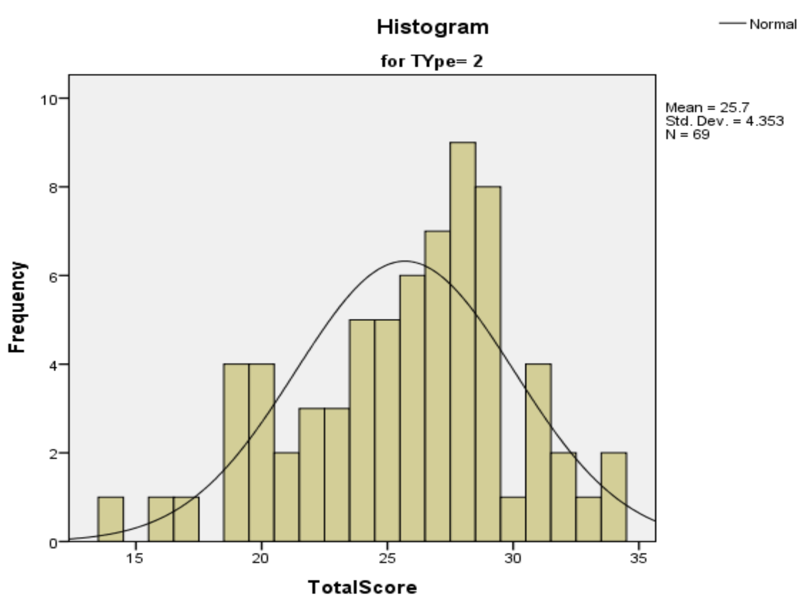

Figure 12. Histogram (Visual indication of normality) for TG1

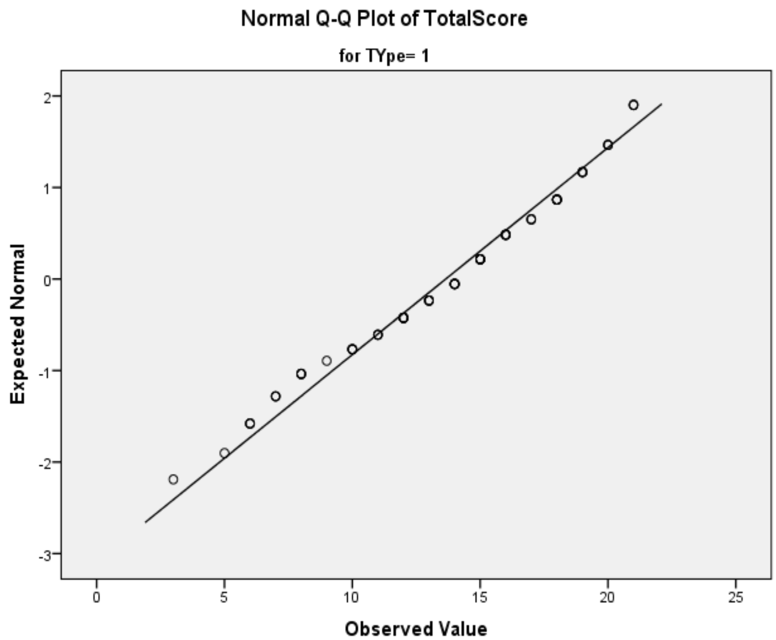

Figure 13. Normal Q-Q Plot of Type 1 (CG) normally distributed

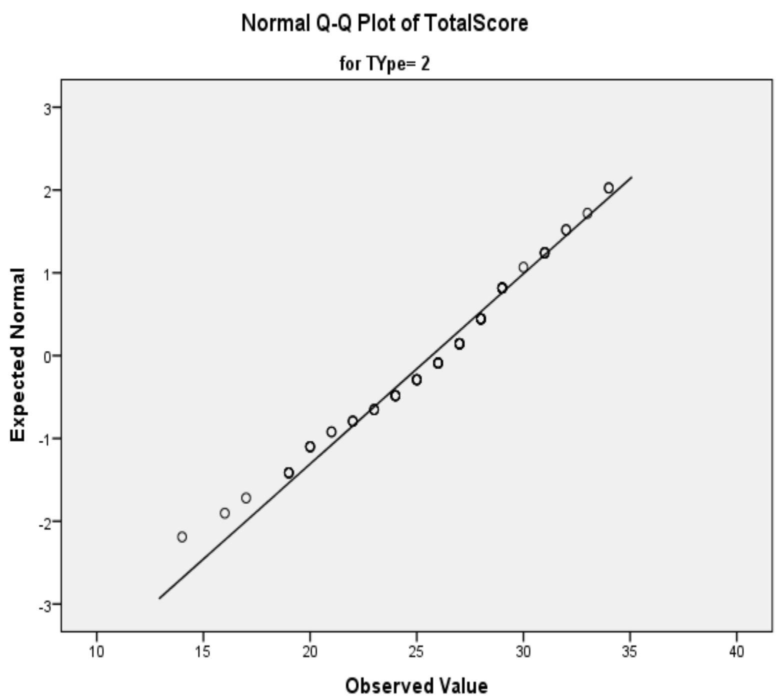

Figure 14. Normal Q-Q Plot of Type 2 (TG1) normally distributed

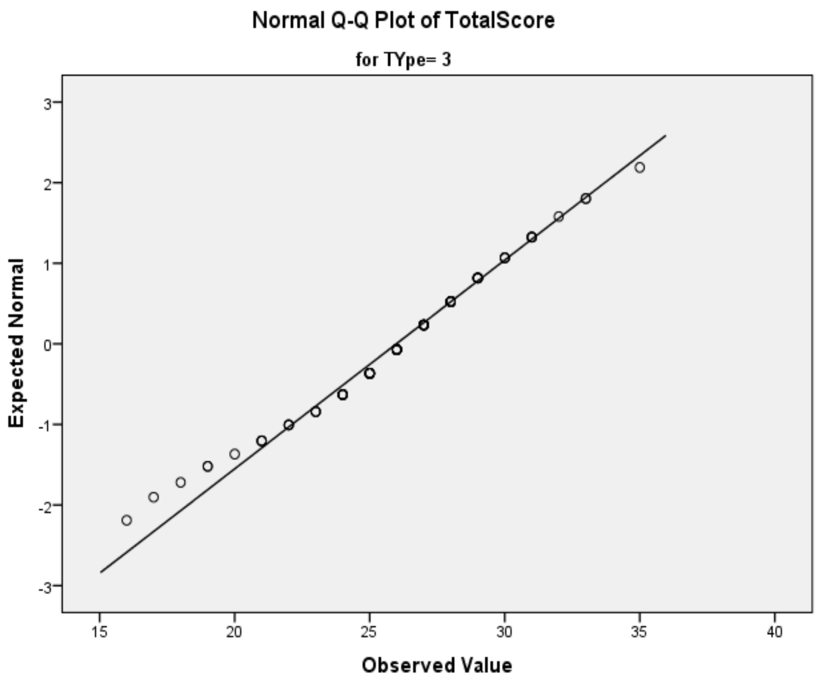

Figure 15. Normal Q-Q Plot of Type 3 (TG2) normally distributed

The Q-Q plot of the type 1, type 2, and type 3 data points were seen to lie almost on the straight line, indicating normality.

The samples were independent. The study employed a random process to select subjects from a long list of business courses. Every subject who contributed to the score was a business major. Once the subject initiated the experiment, the computer generated a random experiment type and delivered it to the subject from one of the three groups. No one, including the experimenter, nor the software, could predict the next experiment.