Gamification in Science Education: The Relationship of Educational Games to Motivation and Achievement

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GAMIFICATION IN SCIENCE EDUCATION: THE RELATIONSHIP OF
EDUCATIONAL GAMES TO MOTIVATION AND ACHIEVEMENT

by

Kelly Elizabeth Rouse

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

May 2013
ABSTRACT

GAMIFICATION IN SCIENCE EDUCATION: THE RELATIONSHIP OF EDUCATIONAL GAMES TO MOTIVATION AND ACHIEVEMENT

by Kelly Elizabeth Rouse

May 2013

Community colleges have become increasingly more important in America’s higher education system. Part of this emphasis has been directly due to President Obama’s 2010 directive to produce a competitive workforce in the United States by increasing the community college graduation rate by five million over the next decade (Madhani, 2010). Community colleges allow open admission for students which permits marginally prepared students to enter. These students may lack motivation, which contributes to student attrition (Williams, 2010). The focus of this study is to examine methods that may improve student learning and motivation, which could ultimately lead to higher graduation rates.

This study investigates the relationship of gamification to motivation and achievement in a community college microbiology class. Gamification is defined as “the process of adding game mechanics to processes, programs, and platforms that would not traditionally use such concepts” (Swan, 2012). The goal of game-based learning is to increase student motivation and learning. The results of this investigation indicate that educational games increase motivation and achievement of students in a community college microbiology class.
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by

Kelly Elizabeth Rouse

A Dissertation
Submitted to the Graduate School of The University of Southern Mississippi in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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May 2013
DEDICATION

I dedicate this work to the memory of my sister, Karen Rouse Carter.
ACKNOWLEDGMENTS

I deeply appreciate the contributions of my committee: Dr. Sherry Herron, Dr. Sheila Brown, Dr. Mac Alford, Dr. Kyna Shelley, and Dr. Bandana Kar. Each of these individuals has inspired me greatly. Dr. Herron has shown me how to keep a positive attitude and persevere in any situation. Dr. Brown has demonstrated dedication and tireless efforts throughout her career, and she encouraged me to pursue a college teaching pathway. Dr. Alford has taught invaluable information that truly changed the way that I look at life. Dr. Shelley has patiently directed me through trying times in this process. Dr. Kar has invested a great deal of time in guiding my ideas. I deeply appreciate Dr. John Keller and Dr. Ming-Puu Chen for kindly allowing me to utilize their instruments in this study.

I am grateful to my family for teaching me the importance and value of education. My parents, Calvin and Bobbie Jean Rouse, sacrificed so that I could have the opportunity to go to college. My grandparents, William and Mattie Rouse, encouraged me to try my very best in any endeavor. My grandparents, Riley and Ethel Mae Keel, were proud of all of my accomplishments and taught me to enjoy learning. My aunt, Elaine Schafer, inspired me to continue my educational journey throughout my life.

Angela Bruni and Lynn Singletary have been my inspiration, study partners, confidantes, and dear friends throughout this process. We started and completed this difficult process together, and I would not have wanted it any other way. There is no way to ever thank the two of you enough.
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CHAPTER I
INTRODUCTION

According to the American Association of Community Colleges (2010), America’s economic strength is determined by the education and skills of its workers, and in order to maintain competitiveness in an ever growing world economy, we must strive for improvement in our educational system. It is projected that 8 in 10 new jobs will require workforce training and higher education over the next decade. Therefore, President Obama has set two national goals to meet this need by 2020. He has charged America’s community colleges to produce an additional 5 million graduates, and according to the American Association of Community Colleges (2010) he proclaimed that the United States will have the highest proportion of college graduates in the world. President Obama stated the following during his proclamation:

Now is the time to build a firmer, stronger foundation for growth that will not only withstand future economic storms, but one that helps us thrive and compete in a global economy. It’s time to reform our community colleges so that they provide Americans of all ages a chance to learn the skills and knowledge necessary to compete for the jobs of the future (American Association of Community Colleges, 2010).

The importance of community colleges continues to rise to produce a more educated public. According to the American Association of Community Colleges (2010), there are a total of 1,165 community colleges in the U.S. These institutions have a total enrollment of 12.4 million students with 40% being enrolled full-time and 60% of the
students enrolled part-time. Approximately 44% of all undergraduates in America are enrolled in community colleges (American Association of Community Colleges, 2010).

Community college students are unique in many ways. They are increasingly becoming non-traditional students who exhibit high stress levels due to juggling a multitude of responsibilities including family, jobs, and school. The average age of community college students is 28. Fifty-four percent of these students are women. The average income of 29% of these students is less than $20,000. Fifty-eight percent of these individuals have full-time jobs, and 22% of the students who work full-time are also enrolled in classes full-time. Additional stress results from fear of failure and fear of rejection by other students or faculty (Johnson, Schwartz, & Bower, 2000). Community colleges provide open access to students. This open access allows all applicants to be admitted. Therefore, some students who are marginally prepared may be allowed admission to difficult programs. According to Perin (2006), 42% of students who enter community colleges need remedial courses in reading, writing, or math, which may be the foundation of an attrition rate of community college students that is higher than that of students who are enrolled in four year schools. Approximately 40% of all students enrolled in community colleges will actually complete their programs, while 57% of students enrolled in four year schools will successfully complete their degrees (Madhani, 2010).

This situation is further exacerbated when ill-prepared students major in challenging subjects, such as nursing. Community colleges play an integral role in educating future nurses. In 2004, the American Association of Colleges of Nursing (2011) reported that 87,085 students took the nursing qualifying exam, the National
Council Licensure Examination for Registered Nurses (NCLEX-RN). Sixty-one percent of these students had associate’s degrees, while 35% held baccalaureate degrees and 4% had health care diplomas. In 2009, Dr. Peter Buerhaus, workforce analyst, projected that the U.S. nursing shortage will increase to 260,000 registered nurses by 2025 (American Association of Colleges of Nursing, 2011). These statistics indicate that the role of community colleges will intensify in order to provide well trained nurses to fill this shortage in the near future.

Statement of the Problem

The fact that community colleges are increasingly becoming more important in the educational and economic future of this nation necessitates an improvement of the success of these institutions. The high attrition rates in community college students tend to be due to lack of academic preparation, as well as outside stresses such as family and work, which lead to a decrease in the students’ motivation to succeed. Williams (2010) cited engulfing demands and lack of motivation as contributing to student attrition. Due to these aforementioned reasons, the community college science instructor is charged with the daunting task of motivating students to achieve academic success in spite of these students being marginally prepared and demographically subjected to high attrition rates.

Research suggests that students who are motivated and actively engaged in the learning process perform better in the classroom than those who are not (Williams, 2010). This study is designed to determine if the use of educational games in a community college microbiology classroom increases motivation and ultimate achievement by examining levels of motivation and performance on pretests and posttests of students who
participate in educational games and those who do not participate in those games. Two questionnaires will be used to survey students’ levels of motivation. These instruments will include the Instructional Materials Motivation Survey (IMMS) (Keller, 1999) and the Flow experience questionnaire (Csikszentmihalyi, 1990), which are designed to allow students to reflect on their thoughts and feelings experienced during participation in educational games. This study will further examine the influence of various demographic factors such as ethnicity, gender, and age on motivation levels and achievement of students who participate in educational games and those who do not.

Research Questions and Hypotheses

Overarching Research Question: Does participation in educational games affect motivation and achievement in a community college microbiology course?

Specific Research Question One: Are there differences between the motivation levels of students who participate in educational games and those who do not participate in educational games?

Research Hypothesis One: There will be significant differences between the motivation levels of students who participate in educational games and those who do not participate in educational games.

Specific Research Question Two: Are there significant differences in pretest and posttest scores between students who participate in educational games and students who do not participate in educational games?

Research Hypothesis Two: There will be significant differences in pretest and posttest scores between students who participate in educational games and those who do not participate in educational games.
Specific Research Question Three: Do demographic differences influence motivation and achievement of students who participate in educational games and those who do not participate in educational games?

Research Hypothesis Three: There will be significant differences in motivation and achievement due to demographic influences between students who participate in educational games and those who do not participate in educational games.

Definition of Terms

The following terms are defined as they are used in this study.

**ARCS model of motivational design** - a construct which measures the degree to which an instructor stimulates the learner’s attention, makes the material relevant, and instills a sense of confidence and satisfaction in the student.

**Autotelic** - self goal or an intrinsic reward.

**Clickers** - Dymo Mimio Vote student response devices that were used with Mimio Studio software to provide real time information about student learning.

**Constructivism** - learning theory which is based on the idea that learning is an active process in which the learner builds new knowledge based on prior understanding and experience.

**Educational games** - competitive activities governed by rules and regulations which provide a mechanism for connecting experience and understanding to allow students a better grasp of the world.

**Flow theory** - a state of intense concentration where an individual’s challenges are matched by the ability to solve the challenge which results in a feeling of pleasure.
Gamification - the process of adding game mechanics to processes, programs, and platforms that would not traditionally use such concepts.

Motivation - tendency to find academic activities meaningful and worthwhile which results in an attempt to derive the intended academic benefits from them.

Peak experiences - moments of highest happiness and fulfillment.

Play - an activity which allows an individual to assimilate reality without threat of failure.

Zone of proximal development - gap between unfulfilled wishes and reality that creates an opportunity for learning when children interact with their environment and with others.

Delimitations

The results of this study are limited to the particular students who were enrolled in a southern community college microbiology class during the Fall 2012 semester. The participants were given class time to participate in educational games and complete the motivation questionnaires.

Limitations and Discussion

The results of this study are limited to community college microbiology students during the Fall 2012 semester. These students are pre-nursing students, and they are not composed of an equal distribution of genders, ages, or ethnicities.

Assumptions

The assumptions of this study are that participants will thoughtfully and accurately answer questionnaires and complete tests. Students have the potential of just responding without thoroughly reading and thinking through each question.
Justification for the Study

According to Madhani (2010), community colleges have the opportunity to educate and impact the future workforce of America, and to reach this goal, it is imperative that community college students are motivated to accomplish academic excellence. The theoretical premise crucial to this study is exemplified by the idea that when students are able to have positive emotions during the learning process they are more enthusiastic about learning, and they tend to study more so that they learn more. When teachers demonstrate the fun, excitement, and beauty of a subject by allowing students to participate in the acquisition and construction of knowledge, the student will be more relaxed and positive in the classroom. Furthermore, participation in educational games affords an environment that offers group support and cooperation, which establishes this positive attitude in the learner and allows the learner to deeply process the material and thereby learn more.

Research indicates that the use of games has improved enjoyment, motivation, and long term retention (Glynn & Koballa, 2006; Hancock, 2002). Properly applied motivational strategies positively impact academic achievement more than memorization of facts (Blakely, Skirton, Cooper, Allum, & Nelmes, 2009). When students actively participate in the learning process the educational experience becomes engaging and motivational for the student.

Educators are charged with the difficult yet extremely important task of educating students. Keller (1999) reported that a lack of motivation is a major cause of student attrition; however, effective educators have the ability to directly increase the level of motivation of students. Keller (1999) further demonstrated that students feel motivated to
learn when teachers ensure that they stimulate the learner’s attention, make the material relevant, and instill a sense of confidence and satisfaction in the student. Keller’s (1999) Attention Relevance Confidence Satisfaction (ARCS) model of motivational design is measured using the Instructional Materials Motivation Scale (IMMS), which assesses students’ levels of attention, relevance, confidence, and satisfaction in an educational activity.

Instructors may also increase the intrinsic motivation of the student by providing enjoyment in the educational setting. This enjoyment will stimulate positive feelings of success and reinforce motivation. According to Csikszentmihalyi (1990), flow is a state of intense concentration that is achieved when an individual’s challenges are matched by the ability to solve the challenge. The goal of many educational games is to keep a player in a flow state to promote feelings of success, which improve motivation. Csikszentmihalyi’s (1990) flow experience questionnaire measures the degree to which a person feels completely immersed and motivated in an activity.

Community college science teachers and students could greatly benefit from educational constructs that result in a more effective learning environment for all. Therefore, the purpose of this investigation is to determine if a relationship exists between participating in educational games and student motivation and achievement in a community college microbiology class.
CHAPTER II
REVIEW OF RELATED LITERATURE

Introduction

Gamification is a term that has recently become more common in the popular press after scientists developed a game to involve citizens in the process of solving a problem in Acquired Immune Deficiency Syndrome (AIDS) research. According to Khatib (2011), after years of effort scientists elicited the help of gamers to solve the structure of a protein so that drugs could be developed to specifically target a protein in the Human Immunodeficiency Virus (HIV) to inhibit the proliferation of this virus. Khatib (2011) reported that the goal of less than half of the participants was to contribute to scientific research, and the majority of the individuals participated in the gamification of HIV research for the social involvement and because the game was immersive and fun.

Educational games are defined as competitive activities governed by rules and regulations which provide a mechanism for connecting experience and understanding to allow students a better grasp of the world (Rieber & Noah, 2008). Games are one of the earliest forms of instructional technology (Rieber & Noah, 2008), and they are considered by educators and students to be effective because they are fun (Prensky, 2007). The use of educational games may be valuable in the community college science curriculum because educational games allow interactions among students, provide active learning, and some games simulate real life situations and complex work environments. According to Blakely et al. (2009), educational games also allow a wide variety of experiences in a short time, increase communication, and enhance motivation.
Theoretical Foundation

The basis of the use of educational games to enhance learning is supported by the ideas of constructivism, as they are seen through a framework of gaming and motivation as is represented by Figure 1. Constructivism is a learning theory that is based on the idea that learning is an active process in which the learner builds new knowledge based on prior understanding and experience. Thomas and Brown (2011) propose that game playing allows students to engage in productive inquiry to learn new material. This act of inquiry then becomes the impetus for involvement and imagination to solve problems, which allows the student to construct their own knowledge that can then be used to motivate students to solve future problems.

Figure 1. Relationship of educational games to constructivism and motivation.

Play is used in the context of game-based learning as something one chooses to do which is intensely and utterly absorbing and which promotes the formation of social groupings (Prensky, 2007). According to Prensky (2007) the *Oxford English Dictionary* assigns 39 definitions to play. Play is defined by Robert Fagan as “optimal generic
learning by experimentation in a relaxed field” (as cited in Prensky, 2007, p. 113).

Einstein supported the importance of play in individual success in his reputed quote, “If A is success in life, A equals x plus y plus z. X is work, y is play, and z is keeping your mouth shut” (as cited in Prensky, 2007, p. 114).

Children use play and imagination as a mechanism to cope with new information. Jean Piaget (1961), child development psychologist and a leading constructivist, supported the idea that play is used by children to comprehend new information even during the earliest stages of development. In today’s ever changing world, children and adults must constantly assimilate new information. Therefore, according to Thomas and Brown (2011), play becomes a strategy for embracing change. Furthermore, play and imagination can actually be used as key components of innovative learning. Play is used to unite new information and the learning environment to create a new culture of learning in which learners engage in play to construct new knowledge daily.

*Constructivism and Play*

According to Colburn (2000), constructivism refers to a philosophical view of reality and perception, but constructivism can also be used to refer to how people learn and to a vast array of teaching styles. Constructivists hold that individuals construct their own knowledge based on prior experiences and viewpoints. The constructivist learning theory proposes that students are not *empty vessels* who come to class *tabula rosa* or *blank slate*. Constructivists propose that teaching is a matter of trying to help students modify their previous beliefs so that they are more in line with the scientific community.

Leading constructivists include Jean Piaget, John Dewey, Lev Vygotsky, and Jerome Bruner. These theorists agreed that game playing is important in preparation for
future life. Thomas and Brown (2011) advocated the constructivist learning theory by proposing that “where imaginations play, learning happens” (p.118).

Jean Piaget (1961), a leading Swiss constructivist, suggested three essential factors necessary for learning, which are maturation, physical experience, and social interaction. He further supported the idea that new ideas are incorporated into an existing body of knowledge in an individual. Therefore, knowledge is obtained by assimilating new ideas into this existing body (Piaget & Inhelder, 1969). According to Piaget (1961), play is an integral part of knowledge acquisition and is crucial to the development of the person as a whole. Piaget (1961) promoted the idea that play is an assimilation of reality to the individual without threat of failure. Piaget (1961) further asserted that a primary function of play is essentially affective because play can serve to improve the emotional outlook of the individual.

According to Piaget (1961), there are four basic categories of play, which include exercise play, symbolic play, games with rules, and games of construction. Exercise play is a primitive form of play which consists of repeating activities for the pleasure of it. Symbolic play is the action of assimilating by using a symbolic language that is developed by the individual. This type of play helps in the resolution of conflicts and the satisfaction of needs, and serves as a means of extending the individual. Games with rules are passed from child to child and are integral in the child’s social life. Games of construction are founded in symbolic play, but they allow the individual to develop solutions to problems as well as to create intelligent constructs (Piaget, 1961). Piaget (1961) and John Dewey (1916/2011) promoted play because students learn more when they enjoy the process.
John Dewey (1916/2011) supported the use of play in education to make going to school enjoyable and the learning easier. He also proposed that students interact and experience their environments in order to learn. Dewey (1916/2011) supported infiltrating the curriculum with play to achieve positive intellectual and moral growth of the student, and he advocated that the more the activity approximates daily experience the more real the knowledge that will be acquired in the experience. Play allows for recreation, which is a recuperation of energy as the name implies. However, play is not simply for amusement, but work that is filled with play results in an enjoyable activity that promotes intrinsic motivation. Dewey’s ideas of the importance of play are summed by his statement, “Education has no more serious responsibility than making adequate provision for enjoyment of recreative leisure; not only for the sake of immediate health, but still more if possible for the sake of its lasting effect upon habits of mind” (Dewey, 1916/2011, p. 113). Dewey (1916/2011) and Vygotsky (1978) agreed students learn more when they are active.

Another leading constructivist, Lev Vygotsky (1978) established the zone of proximal development, which hypothesizes that children learn only when they are involved in stimulating interaction with their environment and with others. Vygotsky (1978) claimed that through successful assimilation of knowledge learners gain the motivation to undertake more complex challenges.

Vygotsky (1978) also supported the use of play to reduce tension, which helps to develop the social conceptual needs for gratification. Vygotsky (1978) further encouraged the use of play in educational endeavors by expressing that play may bridge the gap between unfulfilled wishes and reality. This gap is labeled by Vygotsky as the
zone of proximal development, which creates the opportunity for learning (Vygotsky, 1978). Vygotsky (1978) and Bruner (1965) agreed that play is necessary to provide social interaction.

Finally, Jerome Bruner (1965) established the spiral curriculum in which ideas are introduced in a logical, orderly manner, progressively revisiting the subjects in more detail as the student matures. Bruner further suggested the use of imagery, language, and action in the learning process. He believed that true learning occurs due to internalization dependent upon interaction with others.

Bruner (1965) agreed that play is an important concept by denoting play as a means for individuals to practice actions in an environment that is less risky than reality. He indicated that individuals face a decision where they will either create or stagnate, and in order to maintain a creative atmosphere the student should be allowed to discover new concepts and ideas. In this manner the student will put together ideas to form new knowledge. This use of play allows the student to go beyond the existing information to reassemble new information (Bruner, 1965).

Modern theorist Robert Gagne also agreed with these constructivists that games are important in the learning process. According to Gagne (1985), when adult learners are presented with information, certain factors must be present to ensure that learning takes place. He further proposed that games may be incorporated during many of these steps to successfully accomplish learning. These factors are referred to as Gagne’s Nine Events of Instruction (or Learning) and are represented in Figure 2.
The first five steps involve the presentation of learning material by the teacher to the students. The first step is to gain attention through using questioning, storytelling, or surprise to engage the student. The next step involves informing the student of the learning objectives so that they clearly understand what is expected of them. Next, step three, includes stimulating recall of prior learning because most students, especially adult learners, tend to retain information better if it is related to something that they already know. Step four is referred to as scaffolding because it builds on previous knowledge, adds more details, and allows the learner to perform. Step five includes presenting.
students with new information, which is best accomplished using examples and real-life situations so that the students can internalize the content.

Steps six through nine provide excellent opportunities for the incorporation of games into the curriculum because they include the instructor eliciting a response from the students, guiding appropriately, and allowing opportunities for appropriate application of knowledge. Step six involves the teacher guiding students during learning activities through communication. Step seven includes providing feedback as an additional means of guidance through comments about the student’s performance, which will allow the student to correct any mistakes that he or she has made. Step eight includes assessing performance of the student, and the assessment should closely match the stated objectives. Finally, step nine includes enhancing student retention and transfer by allowing students to apply their knowledge in new situations outside of the classroom. According to Gagne (1985), these events of instruction allow the student to effectively learn.

**Conceptual Framework: ARCS Model and Flow Theory**

Motivation is a student tendency to find academic activities meaningful and worthwhile, which results in an attempt to derive the intended academic benefits from them (Glynn & Koballa, 2006). Research suggests that students who are motivated and actively engaged in the learning process perform better in the classroom than those who are not. If students recognize the importance of learning activities, they are more likely to derive the intended academic benefits from them.

One of the most important benefits of the use of educational games is an increase in motivation for the participant. Properly designed educational games benefit students
by allowing them to develop new skills and utilize those skills in the real world. Karoulis and Demetriadis (2005) report two aspects of educational games, which are process and reward. The act of playing the game is the process, and it includes the interaction and content of the game. The reward is the internal benefit of the game or the feeling of satisfaction that is experienced by the player as the game is played. Another benefit of educational games is that many games are social activities which allow the players to build relationships. Karoulis and Demetriadis (2005) further report that it is commonly established that motivation is referred to as the sine qua non (outcome) of successful learning, and should be thoroughly examined so educational practices can ultimately be enhanced.

Motivation can be examined in terms of many theoretical concepts. According to Campbell (1991), Maslow’s need theory, Herzberg’s hygiene theory, and Equity theory are some of the currently accepted theories of motivation. In addition the Expectancy-Value theory (Huang, Huang, Diefes-Dux, & Imbrie, 2006) provides further examination of motivation. Motivation theories are represented in Figure 3.
Motivation Theories

Figure 3. Motivation Theories.

According to Campbell (1991), motivation consists of three basic components that activate, direct, and sustain human behavior. For continued appropriate action to take place, individuals should be encouraged by a conducive and supportive environment. Motivation is traditionally thought of as being under intrinsic control or extrinsic control. Internal motivation is not controlled by an individual, but it can be influenced by the individual. External motivation is created and controlled by others. Lack of appropriate role models, encouragement, and suitable rewards are the top reasons that students give for not adhering to high academic standards. This information is excellent news to educators because it indicates that teachers can indeed stimulate and even sustain motivation by using educational games that are characterized by providing players with encouragement and rewards (Campbell, 1991).

Maslow’s need theory is based on Abraham Maslow’s concept that humans have five basic needs, which include physiological needs of safety and security, belonging, social activity, esteem, and self-actualization (Campbell, 1991). Maslow (1964) also...
made significant contributions to the study of peak experiences, which are moments of highest happiness and fulfillment. He supported the idea that even though these peak experiences are temporary their effects on motivation may be lasting. Educational games provide students with social activity, which may increase motivation by providing peak experiences.

Herzberg’s hygiene theory indicates that motivation is affected by positive factors and hygiene factors. The positive factors include responsibility, advancement, challenge, recognition, achievement, and growth. The hygiene factors do not actually provide positive motivation, but if they are absent, dissatisfaction will arise. The hygiene factors include wages, job security, benefits, supervision, and interpersonal relationships (Campbell, 1991). The use of educational games in the classroom provides responsibility, challenge, and recognition and also encourages the development of interpersonal relationships, which may enhance motivation in students.

Equity theory is also known as the theory of social comparison, and it proposes that individuals are motivated by the extent to which they feel that they are being treated fairly (Campbell, 1991). This theory can be used to examine student motivation during participation in educational games because educational games provide an adequate environment for the student to interact with others in a fair setting.

Expectancy-value theory, according to Huang et al. (2006), is one of the most comprehensive motivation theories. This theory suggests that individuals approach the world according to their beliefs and evaluations. Therefore, behavior is directly dependent on expectancy, which is the person’s belief that he or she can achieve a goal and value, which is the importance of a goal. The expectancy-value theory is integral in
understanding a person’s will. The concepts of this theory indicate that teachers can motivate students by establishing clear objectives so that students know that if they work hard enough they can accomplish the goal. Furthermore, teachers can encourage students by using educational games to relate content to educational goals.

In an attempt to examine these theories as they are used to evaluate the use of educational games to enhance motivation John Keller’s Attention Relevance Confidence Satisfaction (ARCS) model and Mihaly Csikszentmihalyi’s Flow theory will be utilized. According to Keller (2008), the ARCS model is an amalgamation of these theories because it incorporates the effects of external influences on behavior in light of the influences of internal psychological constructs to produce outcomes. According to Csikszentmihalyi (1990), flow is a state that is accomplished by becoming completely immersed in an activity to the point that the individual achieves a state of enthusiasm and engagement that leads to a deep understanding of the material that is being presented.

**ARCS Model**

John Keller’s (2008) Attention Relevance Confidence Satisfaction (ARCS) model of motivational design is used to diagnose motivational problems and incorporate appropriate motivational tactics into instruction. The ARCS model examines motivational levels based on four dimensions of motivation, which are Attention, Relevance, Confidence, and Satisfaction. The ARCS model is represented in Figure 4. These four factors are a measure of a person’s effort to accomplish a goal, and all factors can be measured independently during game play.
According to Keller’s model (2008), attention is a measure of a person’s curiosity. Instructors can enhance attention by using unexpected events such as songs, noises, or props to stimulate curiosity and the use of variety to keep the attention of the student. Relevance indicates a person’s motives or values, which actually demonstrate the importance of a topic to an individual (Keller, 2008). Teachers demonstrate relevance by connecting the content of instruction to educational goals of the students, their interests, and their learning styles. Educational games allow teachers to relate content to goals and interests of the students. According to Keller (2008), confidence is a measure of a person’s expectancy for success. Many students may have low confidence in a course because they are unaware of the instructor’s expectations. Teachers can instill a sense of confidence by establishing clear objectives and providing examples of assignments that meet requirements. If students understand that success is determined by their degree of effort, then they are much more likely to have confidence in their ability to achieve
success. Finally, satisfaction is determined by many environmental factors including teacher enthusiasm, quality of instruction, and clarity of expectations, all of which may influence students’ performance and their feelings about that performance (Keller, 2008). Students tend to be motivated when they are attentive, interested, and challenged, but satisfaction is required to sustain motivation. Teachers can assist students in achieving satisfaction by giving appropriate recognition and treating students fairly. Recognition can include extrinsic rewards such as simple notes, grades, or privileges. Opportunities to apply knowledge tend to support intrinsic feelings of satisfaction (Keller, 2008).

Flow Theory

According to Csikszentmihalyi’s theory of optimal experience (1990), flow is a psychological state that is achieved when humans enjoy a learning experience. The name is derived from the idea that when a person is completely immersed and enjoying an experience they feel as though a water current is carrying them along.

The flow theory has been established as a useful framework within which play and educational games can be analyzed. According to this theory, flow is completely focused motivation. The flow state is accomplished when a person is involved in a situation that is challenging, but the person’s skills are adequate to meet the challenge. When a person is in the flow state he or she is completely immersed in the task at hand and loses awareness of everything else. Csikszentmihalyi (1990) identifies the following ten factors that are necessary to achieve flow: clear goals, a high degree of concentration, a loss of self-consciousness, distorted sense of time, immediate feedback, balance between ability level and challenge, personal control over the situation, intrinsic rewards
(autotelic), lack of awareness of bodily needs, and absorption into the activity. Factors necessary to achieve flow are represented in Figure 5.

![Figure 5. Csikszentmihalyi's factors necessary to achieve flow.](image)

According to Csikszentmihalyi (1990), the autotelic experience is intrinsically rewarding and is the ultimate goal of being in the flow state. The name is derived from the Greek words *auto*, which refers to self, and *telos*, which indicates a goal. Therefore, an activity is autotelic if it is undertaken for intrinsic rewards. Autotelic activities are those in which individuals use high-skill levels to meet a highly challenging situation. These individuals are not necessarily happier, but they feel better about themselves because of their involvement in complex activities. A primary goal of games is to evoke intrinsic motivation to entertain the player. Individuals who play games enter a flow state
to achieve an enjoyable experience, which increases intrinsic motivation (Csikszentmihalyi, 1990).

According to Csikszentmihalyi (1997), it is easy to enter flow while playing games because they have goals and rules which allow the player to participate without questioning next actions. Csikszentmihalyi (1997) reports that both U.S. teens and adults experience flow as defined by high-challenge that is met with high skill 13% of the time during television watching, 34% of the time when they are engaged in hobbies, and 44% of the time when they are participating in games and sports.

Educational Games

Prensky (2008) supports the idea of achieving a flow state during involvement in educational games and further proposes that there are several rules of engagement when educational games are used in the classroom. These rules are simply characteristics that are exemplified by effective games. Prensky’s characteristics of effective games are represented in Figure 6. These rules include exhibiting clear goals and requiring players to make decisions, usually based on discussions. Effective games allow students to make an emotional connection and participate in cooperation and competition. Engaging games are personalized, which means they meet students at their own level. These games provide adequate feedback, and finally, they are considered to be fun, which means that they allow the player to solve a problem mentally.
Figure 6. Prensky's rules of engagement (or characteristics of effective games).

Prensky (2007) indicates that the main role of fun in educational games is to create relaxation and motivation for the student. Dale Carnegie declared, “People rarely succeed unless they have fun in what they are doing” (as cited in Prensky, 2007, p. 107). Educators may be hesitant to call an activity fun because the word may have connotations of being amusing or frivolous. Fun, in the context of game-based learning, refers to an activity which brings enjoyment and pleasure to the participant.

An examination of the literature has revealed several studies which examine the effects of gaming on student long term retention (Blakley et al., 2009) and the importance of motivation in learning (Glynn & Koballa, 2006). Prensky (2007) promotes the use of game-based learning as a new learning paradigm. He urges the use of educational games at all levels of education, in business, engineering, and in the military. Beylefeld and Struwig (2007) demonstrated the importance of educational games in enhancing the learner’s emotional state while they are accumulating knowledge by developing a board game to teach medical microbiology. Dr. Seymour Papert emphasizes the fact that
students do poorly in school not because the information is too hard but because it is simply boring (Prensky, 2007).

Rieber and Noah (2008) have expressed the importance of the teacher assisting students’ understanding by using games, which is consistent with Vygotsky’s zone of proximal development. Teachers can create a dynamic learning environment by incorporating games with a traditional didactic teaching method. Albert Einstein emphasized the importance of establishing an appropriate learning environment: “I never try to teach my students anything. I only try to create an environment in which they can learn” (as cited in Prensky, 2007, p. 71).

According to Blunt (2010), there is a critical need for increased motivation in education at all levels. He conducted three separate studies to determine the relationship between the use of video games and learning. This study is quite critical because there are few studies on the effects of game based learning even though $125 million was spent on game–based learning in 2006 without having any real evidence that it truly worked. Blunt compares good video game design to Keller’s ARCS model. Good video game design contains rules, goals or objectives, challenge, and engagement, which Blunt theorizes cause an increase in motivation, leading to an increase in learning and overall academic achievement.

Blunt’s (2010) study examined achievement in three classes which were first year business, third year economics, and third year management classes. The results of these studies show that students who participated in game-based learning scored significantly higher on standardized tests than students who did not participate in game-based learning. There were no significant differences in the scores of males and females whether or not
they participated in games. There were also no significant differences between ethnic groups. Finally, students who were under 40 years of age scored significantly higher after participating in games than students 41 years or older.

Rationale for the Study

According to Madhani (2010), improvement in student motivation and academic success will contribute to a more successful workforce, which will allow the United States to become more competitive in an ever changing world market. President Obama has expressed that he wants an efficient community college system to create a workforce that is ready for the new jobs of the future (American Association of Community Colleges, 2010). A key component of this improvement is in improving motivation of students at the community college level. The literature suggests that the use of educational games produces an increase in motivation and achievement. The literature is scarce about the use of educational games at the community college level. It is important to investigate the use of educational games at the community college level because improved performance of students at this level will be the impetus for the success of our nation’s economy in the future (Madhani, 2010).

Summary

The purpose of this study was to examine the effects of using educational games in a community college microbiology classroom. This study examined motivation by using the Instructional Materials Motivation Survey (IMMS) and the Flow Experience and Motivation Questionnaire. Pretests and posttests were used to determine if the use of educational games causes an increase in academic achievement. Finally, this study examined the effects of various demographic factors such as ethnicity, gender, and age on
motivation levels and achievement of students who participate in educational games and those who do not.
CHAPTER III

METHODOLOGY

Introduction
The purpose of this study was to explore motivation and learning outcomes of community college microbiology students who participate in educational games. In this study, the overarching research question was: does participation in educational games affect motivation and achievement in a community college microbiology course?

Data Analysis
The data were analyzed to address the research questions and hypotheses.

Research Design
A quantitative, quasi-experimental research design was used to address the aforementioned research questions. The participants (instructor and students), the pretest and posttest design, and the game type were kept constant to ensure the effect of the strategy rather than testing the effect of the instructor, test design, or game.

A number of statistical techniques were used to answer the research questions. The dependent variables included posttest scores and motivation levels. The motivation levels were ascertained by using quantitative data from the Instructional Materials Motivation Scale (IMMS) and the Flow Experience and Motivation Questionnaire. The independent variables included participation in control or experimental group, gender, age, and ethnicity.

Descriptive analyses of the data were conducted to determine mean and standard deviation, which were then used in statistical analyses. A multivariate analysis of variance (MANOVA) was used to analyze statistical significance in motivation levels.
between the control and experimental groups. A repeated measures analysis of variance (ANOVA) was used to analyze the differences in pretest and posttest scores based on game participation. A descriptive statistical analysis was used to determine if demographic data significantly impacts posttest scores. All surveys and tests were conducted after receiving permission from The University of Southern Mississippi’s Institutional Review Board (Appendix D) and in accordance with IRB standards.

Participants

Participants included male and female students who were enrolled in a Southern community college microbiology course during the Fall 2012 semester. All the participants were over 18 years of age and, therefore, parent/guardian permission was not necessary. Participants were not excluded due to gender, race, or ethnicity. All three sections, which include the two experimental sections and the one control section, had similar treatments except for the implementation of the game activity in the experimental sections.

The participants were chosen from among three classes of microbiology students. The students in two classes were considered experimental and included 40 students. The students in the third microbiology class were considered the control group and included 22 students. The participants were not randomly selected because they were chosen from among the students who were enrolled in the researcher’s classes. However, the two experimental sections and the one control section were randomly determined.

Instrumentation

Pretests and posttests were conducted to determine participants’ knowledge of each unit (Appendix I). These tests were designed by the researcher and submitted to a
focus group of microbiology instructors to test clarity of the instrument. The pretest and the posttest for each unit consisted of 10 multiple choice items.

Motivation levels were analyzed by the use of two instruments, which were the Instructional Materials Motivation Scale (IMMS) and the Flow Experience and Motivation Questionnaire. Both instruments were used to assess student motivation at the end of each unit. The IMMS is used to address attention, relevance, confidence, and satisfaction. The Flow Experience and Motivation Questionnaire was used to determine students’ levels of flow that had been achieved during the unit. The use of both instruments added strength to the assessment of motivation.

The Instructional Materials Motivation Scale was developed by Dr. John Keller to measure students’ motivational levels according to the ARCS parameters, and validity and reliability has been established by Huang et al. (2006) (Appendix E). The goal for this instrument is to measure levels of student motivation for a particular activity or course. Permission to use this instrument was obtained by e-mail with Dr. Keller (Appendix F). This instrument measures motivation by addressing the subscales of Attention, Relevance, Confidence, and Satisfaction. This instrument took approximately five minutes to administer at the end of each of four units. This survey consists of 26 questions divided into subsections of eight questions on attention, six questions on relevance, six questions on confidence, and six questions on satisfaction. Subjects were asked to rate each question based on the following Likert scale: 1=Strongly disagree, 2=Disagree, 3=Neither disagree nor agree, 4=Agree, 5=Strongly agree.
Scores of the subscales are not considered to be high or low, but they are used as a means of comparing situation specific levels of motivation and comparing motivation at various times or between various groups.

The Flow Experience and Motivation Questionnaire was developed by Dr. Mihaly Csikszentmihalyi (1990) and has been modified by Dr. Ming-Puu Chen and Dr. Li-Chun Wang (Wang & Chen, 2010) (Appendix G). The questionnaire consists of 21 questions and is designed to use a Likert scale to assign a score to students’ levels of motivation with 1 being the lowest and 5 being the highest. Scores of the subscales are not considered to be high or low, but they are used as a means of comparing situation specific levels of motivation and comparing motivation at various times or between various groups. Permission to use the instrument was obtained via e-mail correspondence with Dr. Chen (Appendix H).

Reiber and Noah (2008) define educational games as competitive activities governed by rules and regulations, and Prensky (2008) states that effective games are fun. Using these ideas as the premise for game design, a Jeopardy type game was designed for each unit in this course. The games were subjected to a pilot test by allowing students in a prior semester (Spring 2012) to play the game and give feedback on clarity, content, and overall design. The educational games were comprised of five categories with five questions in each category. The categories were derived from major topics within each unit. The questions were designed to reflect the material assessed in each pretest and posttest. The questions were designed as multiple choice items to allow students to respond using interactive student response devices.
The Dymo Mimio Vote classroom clickers are student response devices that were used with Mimio Studio software to provide real time information about student learning. Each student used a wireless handheld response pad referred to as the clicker to answer multiple choice questions anonymously. The wireless devices interact with the Mimio Studio software to allow student responses to be displayed on a screen. Students were provided with the correct answer immediately after they responded to each question. This immediate feedback allows the teacher to better understand any misconceptions that students may have and provided an opportunity for the student to clarify any misunderstandings. Furthermore, Mimio Studio software provides a grade book that allows the teacher to display student progress at the end of each game, which allows each student to view personal performance as well as performance compared to classmates. This grade book also allowed students to see cumulative progress throughout the course.

The educational game used in this study specifically met the requirements of game design in many aspects. The games allowed students to be aware of the rules of the game and use clickers to respond according to these rules. Students were able to communicate with each other and the instructor during the activity. Each student had to make decisions regarding the correct response to each question. Students were in competition with themselves and each other because they were given immediate feedback and were allowed to see scores that reflected their performance on each unit as well as their progression throughout the course. Furthermore, students were able to compare individual performance compared to performance of other students in the class while everyone remained anonymous through the use of clickers. According to Derringer (2011), these devices allow students to become actively engaged in the learning process.
without fear of embarrassment while competing against classmates and themselves and having fun in the process.

Procedures

Upon approval of MGCCC (Appendix C) and The University of Southern Mississippi’s IRB (Appendix D), an oral presentation of the research study (Appendix B) was given to students in three microbiology classes at Mississippi Gulf Coast Community College during the Fall 2012 semester. Students who were willing to participate in the study signed an informed consent letter (Appendix A). All participating students were assigned an identity code and basic demographic data were ascertained (Appendix K) at the beginning of the study. The student codes were used to replace the students’ names throughout the semester on all pretests, posttests, and questionnaires. Participants were allowed to withdraw from this study at any time without repercussions.

Confidentiality was strictly maintained throughout the study by providing codes to each student so that instead of students’ names the codes were used in the data collection instrument. An independent research associate had access to a list which matched student codes with names, willingness to participate in the study, and demographic information. The researcher was not aware of which students agreed to participate in the study until the end of the semester when all grades were submitted. All data were securely locked in a file cabinet. Electronic data were kept in a password protected file. Data were reported so that readers cannot identify any particular student or associate that student with any specific response.

Students took a pretest for each of four units, a posttest for each of four units, and answered two questionnaires for each of four units. The four units represented the
following content: a) genitourinary and nervous system infections, b) genetics, c) prokaryotes and eukaryotes, and d) viruses and pharmacology. The microbiology content of this study is represented in Figure 7.

Figure 7. Microbiology Content.

Students in the experimental group, which consisted of two classes, took a pretest and then participated in lecture and played an educational game which was followed by the posttest and motivation questionnaires. Students in the control group took a pretest and then participated in lecture and answered a worksheet which was followed by the posttest and motivation questionnaires. After the posttest and questionnaires, students in the experimental class received a worksheet, and students in the control class played a game to ensure that all students had equal access to all educational treatments.

In order to determine if prior knowledge of a concept influences motivation levels during participation in educational games, during week six all subjects were allowed to play the educational game before lecture on the content. Participants completed two motivation questionnaires immediately afterward to establish a control unit to be used as
a baseline for comparison of motivation directly related to game participation exclusively. This unit examined the motivation levels of students who participate in games with no prior knowledge of the subject. The games were conducted prior to the lecture material being presented, and, therefore, the motivation questionnaires were designed to evaluate student motivation levels during game play when they had no knowledge on the subject.

A pretest/posttest design was used in this study. A pretest of 10 multiple choice questions was administered to all students at the beginning of each unit. Participants in the control and experimental groups were taught a unit on a microbiological concept which may have lasted up to two weeks.

After lecture, the experimental group participated in a game (Appendix L) that reinforced the concepts of the lecture, and then they answered two questionnaires which assessed motivation levels. A posttest was given to this group at this time. After the motivation questionnaires and posttests were completed these students received a worksheet for each unit that reinforced the same microbiological concepts.

After lecture, the control group answered questions on a worksheet (Appendix J) which reinforced lecture concepts in each unit, and then this section was surveyed using the same two motivation questionnaires. A posttest was given to these students at this time to test mastery of the microbiological content. After the motivation questionnaires and posttests were complete, this group then participated in the educational game that was designed for the unit.

Students in all sections were subjected to both a game and a worksheet, but the activities occurred in different orders in each of the classes. The purpose of this design
was to establish equity among all sections of the course by allowing all instruments to be available for all students to enhance learning before the summative unit test was given.

Figure 8 illustrates the research design.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Week 3</th>
<th>Week 6</th>
<th>Week 8</th>
<th>Week 11</th>
<th>Week 15</th>
<th>Week 18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>N=40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>O1C X</td>
<td>O1D X</td>
<td>O1E X</td>
<td>O1F X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
<td>O2C</td>
<td>O2D</td>
<td>O2E</td>
<td>O2F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1, Q2</td>
<td>Q1,Q2</td>
<td>Q1,Q2</td>
<td>Q1,Q2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Control</td>
<td>A</td>
<td>B</td>
<td>O1C Y</td>
<td>O1D Y</td>
<td>O1E Y</td>
<td>O1F Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
<td>O2C</td>
<td>O2D</td>
<td>O2E</td>
<td>O2F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1, Q2</td>
<td>Q1,Q2</td>
<td>Q1, Q2</td>
<td>Q1, Q2</td>
<td>Q1, Q2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

*Figure 8. Experimental Timeline. A=Chapters 1-4, B=Control Unit, C=Unit 1, D=Unit 2, E=Unit 3, F=Unit 4, X=Lecture and Educational game, Y=Lecture and Worksheet, Z=Game only, O1=Pretest, O2=Posttest, Q1=IMMS, Q2=Flow.*
CHAPTER IV

RESULTS

The overarching purpose of this study was to determine if the use of educational games in a community college microbiology classroom increases motivation and ultimate achievement by examining the level of motivation and performance on pretests and posttests of students who participate in educational games and those who do not participate in those games. Data were collected from students in a community college microbiology classroom. The results of this study were used to determine if there are differences between the reported motivation levels and performance of students on posttests based on participation in educational games. Additionally, results were examined to determine if demographic differences influence motivation or achievement of students who participate in educational games and those who do not.

Findings

Data were first analyzed quantitatively by using descriptive statistics and frequencies. This study included 62 participants (N = 62). Table 1 shows a representation of the demographic characteristics of the participants based on gender, age, and ethnicity. Participants were not evenly distributed based on demographic categories. The majority of the participants were female, 18-24 years of age, and Caucasian. Participants were composed of 45 females (72.6 %) and 17 males (27.4%). The age distribution included 42 participants who were 18-24 years of age (67.7%), 9 participants who were 25-29 years of age (14.5%), 8 who were 30-40 (12.9%), and 3 who were over 40 (4.8%). The distribution of participants according to ethnicity included 40 Caucasians (64.5%), 14 African Americans (22.6%), 5 Hispanics (8.1%), and 3 Asians.
(4.8%). There were 22 students in the control group (35.5%) and 40 in the experimental group (64.5%).

Table 1

_Frequency Statistics of Gender, Age, and Ethnicity (N=62)_

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>45</td>
<td>72.6</td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
<td>27.4</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>42</td>
<td>67.7</td>
</tr>
<tr>
<td>25-29</td>
<td>9</td>
<td>14.5</td>
</tr>
<tr>
<td>30-40</td>
<td>8</td>
<td>12.9</td>
</tr>
<tr>
<td>40+</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>40</td>
<td>64.5</td>
</tr>
<tr>
<td>African American</td>
<td>14</td>
<td>22.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>Asian</td>
<td>3</td>
<td>4.8</td>
</tr>
</tbody>
</table>

This study was conducted on four units of college level microbiology. The course content is aligned with the state requirements for this course. The units are divided into sections comprised of two or more chapters each. The units are represented in Table 2.
<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Unit</td>
<td>Infections of the Respiratory System</td>
</tr>
<tr>
<td></td>
<td>Infections of the Digestive System</td>
</tr>
<tr>
<td>1.</td>
<td>Microbial Diseases of the Urinary and Reproductive Systems</td>
</tr>
<tr>
<td></td>
<td>Microbial Diseases of the Eye and Nervous Systems</td>
</tr>
<tr>
<td>2.</td>
<td>Microbial Genetics</td>
</tr>
<tr>
<td></td>
<td>Recombinant DNA Technology</td>
</tr>
<tr>
<td>3.</td>
<td>Microbial Nutrition</td>
</tr>
<tr>
<td></td>
<td>Controlling Microbial Growth in the Environment</td>
</tr>
<tr>
<td></td>
<td>Characterizing and Classifying Prokaryotes</td>
</tr>
<tr>
<td></td>
<td>Characterizing and Classifying Eukaryotes</td>
</tr>
<tr>
<td>4.</td>
<td>Characterizing and Classifying Viruses, Viroids, and Prions</td>
</tr>
<tr>
<td></td>
<td>Controlling Microbial Growth in the Body: Antimicrobial Drugs</td>
</tr>
</tbody>
</table>

SPSS (Version 20.0, Sept, 2012) was used for statistical analysis. Student responses for the Instructional Materials Motivation Scale (IMMS), which measures Attention, Relevance, Confidence, and Satisfaction, and the Flow Experience and Motivation Questionnaires were entered for each question and responses were analyzed.
for significant differences between control and experimental groups by using descriptive statistics and Multivariate Analysis of Variances (MANOVAs). Descriptive statistics and a repeated measures ANOVA (Analysis of Variance) were used to analyze significant differences between control and experimental groups in student performance on posttests in each unit. Finally, descriptive statistics were used to analyze the impact of gender, age, and ethnicity on student responses to motivation questionnaires and posttests.

At the beginning of the study all subjects were allowed to play the educational game without having had lecture on the content to establish a control unit to be used as a baseline for comparison of motivation directly related to game participation exclusively. This unit examined the motivation levels of students who participate in games with no prior knowledge of the subject. ARCS and flow total mean scores were quite similar for each group in this control unit and are represented in Figure 9. ARCS subtotals for each group were nearly identical and are represented in Table 3. Flow subtotals for each group were similar and are represented in Table 4. The games were conducted prior to the lecture material being presented, and, therefore, the motivation questionnaires were designed to evaluate student motivation levels during game play when they had no knowledge on the subject. These results indicate that the students in the control and experimental groups experienced similar motivation levels when they participate in the educational game. Furthermore, these mean scores are similar to the mean scores of the experimental group after they had been taught the subject and then played the game.
Figure 9. ARCS and Flow Mean Scores for Control Unit. ARCSCTOT=ARCS total scores for the control unit, FLOWCTOT=Flow total scores for the control unit.

Table 3

ARCS Subtotals for Control Unit

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Attention</th>
<th>Relevance</th>
<th>Confidence</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>22</td>
<td>35.68</td>
<td>27.18</td>
<td>26.00</td>
<td>27.45</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>35.37</td>
<td>27.50</td>
<td>26.21</td>
<td>27.87</td>
</tr>
</tbody>
</table>
Table 4

Flow Subtotals for Control Unit

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Ant.</th>
<th>Exp</th>
<th>Intrinsic Motivation</th>
<th>Extrinsic Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>22</td>
<td>44.77</td>
<td>22.27</td>
<td>12.86</td>
<td>13.95</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>42.13</td>
<td>21.48</td>
<td>12.75</td>
<td>13.60</td>
</tr>
</tbody>
</table>

Descriptive analysis for mean ARCS and flow scores for all units reveal differences in the experimental and control group. Figure 10 reveals these differences.

*Figure 10. ARCS and Flow Mean - All Units. ARCSmean=ARCS mean score for all units, Flowmean=Flow mean score for all units.*
Analyses of ARCS results for each unit reveal that the experimental group scored somewhat higher than the control group in all units. Table 5 displays the results for the ARCS totals for each unit.

Table 5

*ARCS Total Mean Scores*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group</th>
<th>N</th>
<th>ARCS Total Mean Score</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>15</td>
<td>111.9</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>32</td>
<td>116.4</td>
<td>12.0</td>
</tr>
<tr>
<td>2.</td>
<td>Control</td>
<td>20</td>
<td>103.9</td>
<td>19.2</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>33</td>
<td>115.5</td>
<td>12.6</td>
</tr>
<tr>
<td>3.</td>
<td>Control</td>
<td>21</td>
<td>106.9</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>34</td>
<td>120.2</td>
<td>14.2</td>
</tr>
<tr>
<td>4.</td>
<td>Control</td>
<td>21</td>
<td>101.3</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>36</td>
<td>119.8</td>
<td>10.2</td>
</tr>
</tbody>
</table>

The results for the ARCS questionnaire were examined for the specific subscores of *Attention, Relevance, Confidence,* and *Satisfaction* for the control and experimental groups in each of the four units by using descriptive statistics. The experimental group scored higher than the control group in all categories. The significance level of this difference was examined in Research Hypothesis 1. Results of ARCS subtotals for each category are listed in Table 6.
Table 6

*ARCS Subtotals*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group</th>
<th>N</th>
<th>Attention</th>
<th>Relevance</th>
<th>Confidence</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>18</td>
<td>32.5</td>
<td>26.9</td>
<td>25.6</td>
<td>24.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>37</td>
<td>35.4</td>
<td>27.4</td>
<td>26.1</td>
<td>27.8</td>
</tr>
<tr>
<td>2.</td>
<td>Control</td>
<td>20</td>
<td>30.1</td>
<td>26.3</td>
<td>24.0</td>
<td>23.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>34</td>
<td>35.4</td>
<td>27.6</td>
<td>25.4</td>
<td>27.3</td>
</tr>
<tr>
<td>3.</td>
<td>Control</td>
<td>22</td>
<td>28.9</td>
<td>26.9</td>
<td>26.1</td>
<td>24.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>34</td>
<td>35.6</td>
<td>28.2</td>
<td>28.8</td>
<td>27.6</td>
</tr>
<tr>
<td>4.</td>
<td>Control</td>
<td>22</td>
<td>27.9</td>
<td>27.1</td>
<td>24.7</td>
<td>22.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>36</td>
<td>35.9</td>
<td>28.4</td>
<td>28.2</td>
<td>27.3</td>
</tr>
</tbody>
</table>

Motivation levels were further analyzed by using the Flow Experience and Motivation Questionnaire. The data were first examined by using a total score for the Flow Experience and Motivation questionnaire. The Flow Experience and Motivation questionnaire consisted of 21 questions divided into subsections of 10 questions on *flow antecedent*, five questions on *flow experience*, three questions on *intrinsic motivation*, and three questions on *extrinsic motivation*. Subjects were asked to rate each question based on the following scale: 1=*Strongly disagree*, 2=*Disagree*, 3=*Neither disagree nor agree*, 4=*Agree*, 5=*Strongly agree*. Results of Flow total mean scores are listed in Table 7.
Table 7

*Flow Total Mean Scores*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group</th>
<th>N</th>
<th>Flow Total Mean Score</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>19</td>
<td>87.9</td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>35</td>
<td>93.1</td>
<td>7.4</td>
</tr>
<tr>
<td>2.</td>
<td>Control</td>
<td>18</td>
<td>84.8</td>
<td>11.4</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>33</td>
<td>93.5</td>
<td>7.9</td>
</tr>
<tr>
<td>3.</td>
<td>Control</td>
<td>21</td>
<td>87.8</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>33</td>
<td>96.0</td>
<td>7.6</td>
</tr>
<tr>
<td>4.</td>
<td>Control</td>
<td>22</td>
<td>81.1</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>36</td>
<td>95.3</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Flow subtotals were analyzed for each unit. These results reveal that the experimental group scored higher than the control group in most units. Results of Flow subtotals for each category are summarized in Table 8.
Table 8

*Flow Subtotals in Each Category*

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group</th>
<th>N</th>
<th>Ant.</th>
<th>Exp</th>
<th>Intrinsic Motivation</th>
<th>Extrinsic Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>20</td>
<td>42.0</td>
<td>19.95</td>
<td>12.3</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>38</td>
<td>44.5</td>
<td>21.8</td>
<td>12.9</td>
<td>14.1</td>
</tr>
<tr>
<td>2.</td>
<td>Control</td>
<td>20</td>
<td>39.6</td>
<td>19.5</td>
<td>12.2</td>
<td>14.2</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>34</td>
<td>43.5</td>
<td>21.9</td>
<td>13.6</td>
<td>14.2</td>
</tr>
<tr>
<td>3.</td>
<td>Control</td>
<td>22</td>
<td>41.9</td>
<td>19.2</td>
<td>12.2</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>36</td>
<td>46.2</td>
<td>21.8</td>
<td>13.7</td>
<td>14.4</td>
</tr>
<tr>
<td>4.</td>
<td>Control</td>
<td>22</td>
<td>37.1</td>
<td>17.8</td>
<td>12.4</td>
<td>13.8</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>36</td>
<td>45.7</td>
<td>21.5</td>
<td>13.8</td>
<td>14.3</td>
</tr>
</tbody>
</table>

An independent samples t-test was conducted on pretest scores for each unit to establish that the groups began with similar content knowledge (Table 10). Assumption of homogeneity of variance was not met for all units. Violations of homogeneity of variance occurred for unit four. Assuming equality of variances, the t-test was not found to be statistically significant in any unit, and, therefore, there is no significant difference between control and experimental scores for all units before beginning the experiment. Specifically, the two groups can be assumed to be equivalent on pretest scores.
Table 9

**Pretest Scores**

<table>
<thead>
<tr>
<th>Pretest</th>
<th>t</th>
<th>df</th>
<th>Sig (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>-1.432</td>
<td>54</td>
<td>.16</td>
</tr>
<tr>
<td>Unit 2</td>
<td>.907</td>
<td>52</td>
<td>.37</td>
</tr>
<tr>
<td>Unit 3</td>
<td>.000</td>
<td>50</td>
<td>1.00</td>
</tr>
<tr>
<td>Unit 4</td>
<td>.511</td>
<td>32.264</td>
<td>.61</td>
</tr>
</tbody>
</table>

Descriptive analysis of mean pretest and posttest scores for all four units reveals that mean posttest scores increased for both the control and experimental groups. The results are shown in Figure 11.

*Figure 11.* Pretest and Posttest Mean - All Units. Premean=Pretest mean for all units, Postmean=Posttest mean for all units.
The results of unit one indicate a mean pretest score of 54.4 and a mean posttest score of 87.78 in the control group (N = 18). The experimental group (N = 38) scored a mean of 62.1 on the pretest and 93.9 on the posttest. These results are shown in Figure 12.

![Unit One: Mean Pretest and Posttest Scores](image)

Figure 12. Unit One: Mean Pretest and Posttest Scores. Pre1=Mean pretest score for unit 1, Post1=Mean posttest score for unit 1

The results of unit two indicate a mean pretest score of 41.00 in the control group (N = 20) and a mean posttest score of 80.00. The experimental group (N = 33) scored a mean of 36.97 on the pretest and 91.21 on the posttest. These results are shown in Figure 13.
In unit three, the control group ($N = 21$) scored a mean pretest score of 70.0 and a mean posttest score of 86.7. The experimental group ($N = 31$) scored a mean of 70.0 on the pretest and 93.9 on the posttest. These results are shown in Figure 14.
An examination of scores in unit four reveals a mean pretest score of 64.1 and a mean posttest score of 79.5 for the control group (N = 22). The experimental group (N = 33) scored a mean pretest score of 60.9 and a mean posttest score of 98.1. These results are shown in Figure 15.

*Figure 14.* Unit Three: Mean Pretest and Posttest Scores. Pre3=Mean pretest score for unit 3, Post3=Mean posttest score for unit 4.
Figure 15. Unit Four: Mean Pretest and Posttest Scores. Pre4=Mean pretest score for unit 4, Post4=Mean posttest score for unit 4.

A summary of the scores for the mean pretests and posttests for each of the four units is found in Table 10. This table also includes the mean gain score for each unit.
Table 10

Mean Pretest and Posttest Scores

<table>
<thead>
<tr>
<th>Unit</th>
<th>Group</th>
<th>N</th>
<th>Mean pretest</th>
<th>Mean posttest</th>
<th>Mean gain score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>18</td>
<td>54.4</td>
<td>87.8</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>38</td>
<td>62.1</td>
<td>93.9</td>
<td>31.8</td>
</tr>
<tr>
<td>2.</td>
<td>Control</td>
<td>20</td>
<td>41.0</td>
<td>80.0</td>
<td>39.0</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>33</td>
<td>36.97</td>
<td>91.2</td>
<td>54.2</td>
</tr>
<tr>
<td>3.</td>
<td>Control</td>
<td>21</td>
<td>70.0</td>
<td>86.7</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>31</td>
<td>70.0</td>
<td>93.9</td>
<td>23.9</td>
</tr>
<tr>
<td>4.</td>
<td>Control</td>
<td>22</td>
<td>64.1</td>
<td>79.5</td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>33</td>
<td>60.9</td>
<td>98.1</td>
<td>37.3</td>
</tr>
</tbody>
</table>

Results for Research Questions and Hypotheses

Results of Research Question and Hypothesis One

Are there differences between the motivation levels of students who participate in educational games and those who do not participate in educational games?

Descriptive analyses reveal that students who participate in educational games report higher motivation levels than those who do not. Mean scores for ARCS and flow levels are reported in Table 11.
Table 11  

*ARCS and Flow Means*

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>ARCS</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>22</td>
<td>104.76</td>
<td>85.55</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>118.06</td>
<td>94.56</td>
</tr>
</tbody>
</table>

**Research hypothesis one.** There will be significant differences between the motivation levels of students who participate in educational games and those who do not participate in educational games.

A multivariate analysis of variance (MANOVA) was conducted to determine if significant differences exist between the control and experimental groups. The results indicate that there are statistically significant differences in the motivation levels of students who participate in educational games and in those who do not. Students in the experimental group who played an educational game showed a significant increase in overall ARCS totals in all four units, Wilk’s $\lambda=.001$. The ARCS totals were significantly higher in the experimental group, $F(1,61)=19.27$, $p=<.001$. The results further revealed significant differences in each of the ARCS categories, $attention=F(1,61)=22.67$, $p=<.001$; $relevance=F(1,61)=4.17$, $p=.046$; $confidence=F(1,61)=5.95$, $p=.018$; $satisfaction=F(1,61)=16.73$, $p=<.001$.

A further analysis of motivation using the Flow State Scale revealed a statistically significant increase in flow totals in all four units, Wilk’s $\lambda=<.001$. The results for flow totals reveal, $F(1,61)=20.38$, $p=<.001$. Analysis of the subsections of the flow scale reveals a statistically significant increases in flow $antecedent$, $F(1,61)=23.38$, $p=<.001$;
experience, F(1,61)=13.31, \( p=0.001 \); and intrinsic motivation, F(1,61)=6.11, \( p=0.016 \).

However, there was no statistically significant difference in flow extrinsic motivation between the control and experimental groups, F(1,61)=0.034, \( p=0.855 \).

**Results of Research Question and Hypothesis Two**

Are there significant differences in pretest and posttest scores between students who participate in educational games and students who do not participate in educational games?

Descriptive analyses reveal that students who participate in educational games have higher posttest scores than students who do not. Results of mean pretest and posttest for the control and experimental groups are summarized in Table 12.

**Table 12**

*Pretest and Posttest Means*

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>22</td>
<td>57.35</td>
<td>82.95</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>57.21</td>
<td>94.27</td>
</tr>
</tbody>
</table>

**Research hypothesis two.** There will be significant differences in pretest and posttest scores between students who participate in educational games and those who do not participate in educational games.

A repeated measures ANOVA was conducted to determine if a statistically significant difference exists among the mean posttest scores of the control and
experimental groups for all units. Students who participated in educational games scored significantly higher on posttests than those who did not, $F(1,61)=486.57$, $p<.001$.

Research Question and Hypothesis Three

Do demographic differences influence motivation and achievement in students who participate in educational games and those who do not participate in educational games?

This research question could not be adequately addressed in this study because the sample was quite unbalanced with regard to gender, age, and ethnicity. The majority of participants were overwhelmingly Caucasian (64.5%), female (72.6%), and between the ages of 18 and 24 (67.7%).

Research hypothesis three. There will be significant differences in motivation and achievement due to demographic influences between students who participate in educational games and those who do not participate in educational games.

The effect of gender, age, and ethnicity on motivation and achievement of students could not be analyzed statistically because many of the variables in this study resulted in empty or nearly empty cells.

Summary

The research questions were answered by conducting descriptive statistics, frequencies, t-tests, ANOVAs, and MANOVAs. This study analyzed motivation levels and posttest scores of microbiology students in a South Mississippi community college and compared the scores of a control group who did not participate in educational games and an experimental group who participated in educational games. The results of these research questions indicate that students who participate in educational games have
statistically higher scores in motivation and achievement than students who do not participate in educational games; therefore, research hypotheses one and two were supported.
CHAPTER V

DISCUSSION

A summary of this study and a discussion of the results will be presented in this chapter. Limitations of the study will be explained. Recommendations for future research will be proposed. Finally, conclusions formed from the results of this study will be given.

Summary of the Study

The purpose of this study was to determine if a relationship exists between participating in educational games and student motivation and achievement in a community college microbiology class. The results of this study were used to determine if there are differences between motivation levels and performance of microbiology students on posttests based on participation in educational games. Several statistical analyses were used to determine variations in levels of motivation in the control and experimental groups. Motivation levels were determined by using the Instructional Materials Motivation Scale and the Flow Experience and Motivation Questionnaire. Student achievement was measured by comparing posttest scores of control and experimental groups. Finally, demographic differences were considered to determine if they have a statistically significant impact on motivation or achievement in these students.

Description of Sample

The participants in this study included 62 (N = 62) individuals. They were comprised of 45 females and 17 males. The age distribution of this group included 42
individuals age 18-24, 9 who were 25-29, 8 subjects who were 30-40 years of age, and 3 individuals age 40 and over. The ethnic distribution of the subjects included 40 Caucasians, 14 African Americans, 5 Hispanics, and 3 Asians. The overwhelming majority of the participants were Caucasian, female, and 18-24 years of age. This may be explained by considering that the majority of the students in microbiology class are pre-nursing students, and nursing is traditionally a female role. Furthermore, there are historically fewer minorities in the science and medical fields (Association for Professional Employees, AFL-CIO, 2012). These subjects were randomly chosen by class to participate in the control or experimental groups. There were 22 subjects in the control group and 40 subjects in the experimental group.

Description of Study Variables

There were several variables in this study. The variables consisted of the three questionnaires. The demographic questionnaire was used to obtain basic demographic information about each participant. The Instructional Materials Motivation Survey and the Flow Experience and Motivation Questionnaire were given to each participant to collect information about motivation levels. Pretests and posttests were used to collect information on student knowledge. Jeopardy games and Mimio vote student response devices were used to give immediate feedback to the teacher and students about student knowledge.

Analysis of Research Questions and Hypotheses

Research question one. Are there differences between the motivation levels of students who participate in educational games and those who do not participate in educational games?
Statistical analyses reveal that there are statistically significant differences in the motivation levels of students who participate in educational games and in those who do not. Prominent educational theorists have supported the use of educational games to increase motivation for decades. Piaget and Inhelder (1969) supported the use of game playing to increase the emotional outlook of the student. Dewey (1916/2011) and Vygotsky (1978) suggested that students have improved motivation when they are interact with others, have fun, and experience small successes.

Students in the experimental group who played an educational game showed a significant increase in overall ARCS totals and categories in all four units. The ARCS model is used to assess student motivation levels. All factors of this model are important in the overall evaluation of motivation. The findings of this research indicate that significant increases are seen in attention, relevance, confidence, and satisfaction in all units throughout the study. Keller (1999) proposed that students feel motivated to learn when teachers ensure that they stimulate the learner’s attention, make the material relevant, and instill a sense of confidence and satisfaction in the student.

This information is especially interesting in light of the fact that at the beginning of the study both groups, control and experimental were allowed to play a game and answer motivation questions with no exposure to lecture content. An examination of ARCS and flow for this control unit revealed no significant differences between ARCS totals for the control and experimental groups, $F(1,58)=.043$, $p=.836$, nor were there any significant differences for flow totals for these two groups, $F(1,60)=3.070$, $p=.085$.

According to Small (2000), educational games provide interest, variety, and novelty to encourage attention. They increase confidence by establishing clear objectives
and providing feedback as the students proceed, which will ultimately build confidence. Finally, according to Small (2000), the recognition, the successful completion of games, and the feeling of fair treatment that are offered by game play contribute to a feeling of satisfaction in students.

A further analysis of motivation using the Flow Experience and Motivation Questionnaire revealed a statistically significant increase in flow in all four units tested. Analysis of the subsections of the flow scale reveals a statistically significant increase in flow antecedent, experience, and intrinsic motivation in all four units. Flow extrinsic motivation is the only category that showed no significant increase in any unit.

These results are supported by Csikszentmihalyi’s theory of optimal experience (1990), which states that flow is a psychological state that is achieved when humans enjoy a learning experience. Csikszentmihalyi (1997) reports that individuals experience flow 44% of the time when they are participating in games and sports.

Analysis of the significant increase in flow in the experimental groups can be explained by examining the flow theory which is derived from the idea that when a person is completely immersed in an activity they experience flow. Flow is completely focused motivation. Therefore, these results indicate that the students in the experimental group were immersed in the game and completely focused on playing the game in all four units. The results in this study indicate that students had an increase in intrinsic motivation in all four units that were tested. The only category that demonstrated no significant increase was extrinsic motivation. However, this result further supports the claims that games increase motivation by increasing intrinsic motivation.
Research hypothesis one. There will be significant differences between the motivation levels of students who participate in educational games and those who do not participate in educational games.

This hypothesis is fully supported by the results of this study. This study analyzed motivation levels by using two independent instruments, and the results from both the ARCS model and the Flow model demonstrate an increase in motivation levels in students who participate in educational games. These models were used to thoroughly examine motivation levels by comparing overall means, means for each unit, and means for each category of the questionnaire in each unit. The results consistently supported a significant increase in motivation in students who played educational games.

These findings are supported by Prensky (2007) who advocates the use of educational games to increase motivation in all levels of education. He advocates that game-based learning will become the learning wave of the future. He states, “It will soon cut across the entire population, from cradle to grave.” (Prensky, 2007, p. 19)

Research question two. Are there significant differences in pretest and posttest scores between students who participate in educational games and students who do not participate in educational games?

Statistical analyses of posttest scores reveal that these scores increased for both the control and experimental groups in each of the four units. This finding is supported by Blunt (2010), who supports the idea that effective educational games contain rules, goals or objectives, challenge, and engagement, which cause an increase in motivation, leading to an increase in learning and overall academic achievement.
Research hypothesis two. There will be significant differences in pretest and posttest scores between students who participate in educational games and those who do not participate in educational games.

This hypothesis is fully supported by the results of this study. This study examined academic achievement by comparing overall means for each group and means for each unit to thoroughly analyze posttest scores. The experimental group scored significantly higher overall in mean posttest scores. Moreover, the posttest scores were significantly higher for the experimental groups in all four units throughout the study which demonstrated that the novelty of the game did not wear off over the course of the semester.

These results are supported by numerous studies in the literature. Gagne (1985) supports the idea that effective instruction keeps students attention, has clear objectives, stimulates recall, and provides feedback. These characteristics exemplify game-based learning and provide support for the improved posttest scores in this study. Blunt (2010), Glynn and Koballa, (2006), and Karoulis and Demetriadis (2005) indicate that students who participated in game-based learning scored significantly higher on standardized tests than students who did not participate in game-based learning.

Research question three. Do demographic differences influence motivation and achievement in students who participate in educational games and those who do not participate in educational games?

Due to the uneven distribution of gender, age, and ethnicities in this study, this question could not be analyzed effectively. The subjects of this study represent pre-nursing majors who are traditionally characterized as being primarily female. According
to the Association for Professional Employees in 2011, the nursing field as a whole was composed of Caucasian (78%) females (91.1%).

*Research hypothesis three.* There will be significant differences in motivation and achievement due to demographic influences between students who participate in educational games and those who do not participate in educational games.

These differences in motivation and achievement could not be adequately analyzed due to a lack of demographic differences in the student population. The student population in this study does not reflect a wide range of ages and ethnicities, nor an adequate representation of genders.

**Implications for Policy and Practice**

The results of this study could impact educational practices by demonstrating the benefits of the use of educational games. These results provide evidence that educators can use educational games to improve motivation and achievement. According to the outcomes of this study, community college students show an improvement in motivation levels and an improvement in test scores after they participate in an educational game.

Community college students have numerous situations and responsibilities that have the potential to cause a lack of motivation. Williams (2010) cited engulfing demands and lack of motivation as contributing to the poor academic achievement of some community college students. Moreover, 42% of these students may need remedial courses in reading, writing, or math which could also contribute to poor academic achievement, according to Perin (2006).

If educational games are implemented throughout the community college curriculum, an increase in motivation and achievement could decrease the historically
high attrition rates of these students (Madhani, 2010). This will be necessary to increase the graduation rates of these institutions. According to the American Association of Community Colleges (2010), 80% of new jobs in the next decade will require workforce training and higher education. It is crucial that community college instructors make an effort to positively impact student academic success by using effective classroom practices which include educational games according to the results of this study.

Limitations

The participants in this study included microbiology students in a Southern community college who were mainly pre-nursing students. The results of this study cannot be generalized beyond a similar sample. Further limitations include honest and accuracy when completing the motivation questionnaires. Participants may have hurriedly completed the questionnaires without thoroughly reading all questions.

Recommendations for Future Research

While the ideas of educational play were supported by Dewey, Bruner, Piaget, and Vygotsky, gamification is fairly new to modern education. Promising results have been found by this study as well as many others. However, there are several recommendations for future research in this area.

The first recommendation is to conduct a study on a larger sample size. This study was conducted on a sample size of 62 participants. A larger sample size that is more representative of the overall community college demographic should be utilized in future research.
The second recommendation is to test long term retention of participants. This could be accomplished by examining student scores on summative tests at the end of the course.

The third recommendation is to continue this study as a longitudinal study and track these students to analyze attrition rates. An analysis of attrition rates for these students could provide information on the applicability of increased motivation and achievement to overall academic success.

A final recommendation would be to conduct qualitative aspects of the study to ascertain more information about students’ feelings and opinions, as well as suggestions for effective game design.

The purpose of this study was to determine if the use of educational games in a community college microbiology classroom increases motivation and achievement. Gamification did increase motivation and achievement. Future research and implementation of educational games could potentially benefit community college students and the educational system as a whole.
APPENDIX A

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Participant’s Name ____________________________________________

I hereby give my consent to participate in the research project The Relationship of Educational Games to Motivation and Achievement. All procedures and/or investigations to be followed and their purpose, including any experimental procedures, were explained by Kelly Rouse. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected.

The opportunity to ask questions regarding the research and procedures was given. Participation in the project is completely voluntary, and participants may withdraw at any time without penalty, prejudice, or loss of benefits. All personal information is strictly confidential, and no names will be disclosed. Any new information that develops during the project will be provided if that information may affect the willingness to continue participation in the project.

Questions concerning the research, at any time during or after the project, should be directed to Kelly Rouse at (228)896-2531. This project and this consent form have been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

A copy of this form will be given to the participant.

__________________________________________________________________________  __________________________
Signature of participant                                          Date

__________________________________________________________________________  __________________________
Signature of person explaining the study                            Date
APPENDIX B

INFORMED CONSENT LETTER

September 21, 2012

Dear Research Participant:

The purpose of this study is to determine if the use of educational games increases motivation and ultimate achievement by comparing the level of motivation of the student and by comparing the performance on pretests and posttests of students who participate in educational games to those who do not participate in those games. You are being asked to participate in this study because you are currently enrolled in Microbiology. I am asking you to volunteer to allow me to analyze your scores on pretests that are given before a topic is taught and on posttests that are given after a topic is taught. The information gathered has the potential to be beneficial for the improvement of this course.

The risks associated with this study are no greater than normal daily activities. The requirements for participation in this study are very minimal. You must be at least 18 years old to participate in this study. There will be no requirements for any time outside of regular class activities and time required for normal study for class requirements.

Confidentiality will be maintained throughout the study. Names of the participants will not be included on any documents. Your name will be replaced with a code. All data will be locked and secured. Electronic data will be kept in a password protected file. All data will be destroyed within three years after the study is completed.

Participation in this project is completely voluntary. Please feel free to decline participation or to discontinue participation at any point without fear of penalty, prejudice, or any other negative consequence. Please feel free to ask questions about this project or your participation in this study. You may contact me at kelly.rouse@mgccc.edu or (228)896-2531.

By completing and returning the attached consent form the respondent gives permission for this anonymous and confidential data to be used for the purposes described above. This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

Thank you,
Kelly Rouse
APPENDIX C

PERMISSION TO CONDUCT RESEARCH AT MGCCC

Mississippi Gulf Coast Community College

Request to Conduct Research at MGCCC

DIRECTIONS: Individuals who wish to conduct research utilizing MGCCC students or employees must complete this application and email to jason.pugh@mgccc.edu.

Purpose – This application must be completed and approval granted by the MGCCC Executive Council prior to conducting any research utilizing college students or employees. The purpose of this application is to ensure that the researcher complies with the following conditions:

1. Requires the researcher to summarize the proposed research and provide supporting documentation ensuring that research is performed in compliance with all applicable laws, regulations, and institutional and federal policies regarding human subjects research,

2. Ensures the proposed research has institutional support or will have such support through IRB approval and the endorsement of a qualified research advisor (i.e., faculty member) who assumes responsibility for the project,

3. Provides the applicant with appropriate documentation that the MGCCC Executive Council has reviewed the proposed study.

Principal Investigator (PI) Contact Information – The PI for the purposes of this application is the individual who will personally conduct this research study. Under most circumstances, the PI will be the student researcher.

Name: Kelly Rouse
Email: kelly.rouse@mgccc.edu
Address: 2226 Switzer Rd.
City: Gulfport
State: MS
Zip: 39507
Phone: (228)896-2531
Fax:

Research Advisor (RA) Contact Information – The RA for the purposes of this application is the individual who will personally supervise and oversee this research study. Under most circumstances, the RA will be the faculty member working with the student researcher.

Name: Dr. Sherry Herron
Email: Sherry.Herron@usm.edu
Address: 218 College Dr.
City: Hattiesburg
State: MS
Zip: 39406
Phone: (601)266-4739
Fax:

Sponsoring Institution or Agency: University of Southern Mississippi
Sponsoring Academic Division/Department: Center for Science and Mathematics Education

Has the study obtained IRB approval from sponsoring institution?
☐ Yes, Approve Date If Yes, was Study ☐ Exempt or Expedited (deemed minimal risk to human subjects)
☐ No ☐ Full Board (deemed greater than minimal risk or work with special populations of human subjects)
☐ Not Applicable, Explain:

IRB approval is in progress.
Kelly Rouse
Microbiology and A&P I and II Instructor
Mississippi Gulf Coast Community College-Jefferson Davis Campus
2226 Switzer Rd.

Kelly,

The MGCCC executive council approved your request for research today, 8/8/12. You will receive a signed copy of the documentation. I look forward to seeing the results of your work.

JP

Jason V. Pugh, Ph. D.
Vice President
Instruction, Student Services & Related Technologies
Mississippi Gulf Coast Community College
P.O. Box 609
Perkinston, MS 39573
ph: 601-928-6233
e-mail: jason.pugh@mgccc.edu

From: kelly rouse <kelly.rouse@mgccc.edu>
Date: Tuesday, July 24, 2012 7:35 PM
To: Jason Pugh <jason.pugh@mgccc.edu>
Subject: Request to conduct research at MGCCC for Kelly Rouse

Hi Dr. Pugh,

I have taught Microbiology and Anatomy and Physiology I and II at JD since 2005. I am also a doctoral candidate majoring in Science Education with an emphasis in Biology in the Center for Science and Mathematics at USM.

I am seeking approval to use my microbiology students in my dissertation research. I have attached the request to conduct research at MGCCC. I have included supporting documents including pretests, posttests, worksheets, and screenshots of the educational games that will be used throughout the investigation. Questionnaires and the permission to use the adapted questionnaires are included in the supporting documents. The consent form is included. Finally, I have scanned and attached my signature and that of my research advisor.

I hope to have approval to begin the project in the fall semester, and I plan to defend my prospectus in August.

Thanks for your time,
APPENDIX D

IRB APPROVAL LETTER

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the “Adverse Effect Report Form”.

If approved, the maximum period of approval is limited to twelve months.

Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 12092504
PROJECT TITLE: Gamification in Science Education: The Relationship of Educational Games to Motivation and Achievement
PROJECT TYPE: Dissertation
RESEARCHER/S: Kelly Rouse
COLLEGE/DIVISION: College of Science & Technology
DEPARTMENT: Center for Science & Match Education
FUNDING AGENCY: N/A
IRB COMMITTEE ACTION: Expedited Review Approval
PERIOD OF PROJECT APPROVAL: 10/02/2012 to 10/01/2013
Lawrence A. Hosman, Ph.D.
Institutional Review Board Chair
APPENDIX E

INSTRUCTIONAL MATERIALS MOTIVATION SURVEY

Identification number_________________________ Topic___________________________

Please answer the following questions in relation to your experience in the event you have just completed. These questions relate to the thoughts and feelings you may have experienced during the event. There are no right or wrong answers. Think about how you felt during the event and answer the questions using the rating scale below.

<table>
<thead>
<tr>
<th>Rating scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1=Strongly disagree</td>
</tr>
<tr>
<td>2=Disagree</td>
</tr>
<tr>
<td>3=Neither disagree nor agree</td>
</tr>
<tr>
<td>4=Agree</td>
</tr>
<tr>
<td>5=Strongly agree</td>
</tr>
</tbody>
</table>

ATTENTION

1. There was something interesting at the beginning of this topic that got my attention. 1 2 3 4 5
2. This game is eye-catching. 1 2 3 4 5
3. The game helped to hold my attention 1 2 3 4 5
4. The design of this game looks appealing. 1 2 3 4 5
5. This topic has things that stimulated my curiosity. 1 2 3 4 5
6. I learned some things that were surprising or unexpected. 1 2 3 4 5
7. The variety in this game helped keep my attention on this topic. 1 2 3 4 5
8. There are an appropriate amount of words on each power point. 1 2 3 4 5

RELEVANCE

9. It is clear to me how the content of this game is related to things I already know. 1 2 3 4 5
10. Completing this game successfully was important to me. 1 2 3 4 5
11. The content in this game convey the impression that it is worth knowing. 1 2 3 4 5
12. This topic was relevant to my needs because I need to know it. 1 2 3 4 5
13. I could relate the content of this game to my own life. 1 2 3 4 5
14. The content of this topic will be useful to me. 1 2 3 4 5
Please answer the following questions in relation to your experience in the event you have just completed. These questions relate to the thoughts and feelings you may have experienced during the event. There are no right or wrong answers. Think about how you felt during the event and answer the questions using the rating scale below.

**CONFIDENCE**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. When I first looked at this information, I had the impression that it would be easy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. This topic was easier to understand than I thought it would be.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I felt confident that I knew what I was supposed to learn from this topic.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I was able to pick out and remember the important points.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. After this game, I was confident that I would be able to pass the test.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. As I worked on this topic, I was confident that I could learn the content.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**SATISFACTION**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Completing this game gave me a satisfying feeling of accomplishment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. I enjoyed this game so much that I would like to play it again.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. I really enjoyed playing this game.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>24. The feedback during this game helped me feel rewarded for my effort.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>25. It felt good to successfully complete this game.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>26. It was a pleasure to work on such a well-designed game.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
APPENDIX F

PERMISSION TO USE THE IMMS

Dear Kelly,

Thank you for your nice message. I appreciate your comments!

You are certainly welcome to use the IMMS in your research. Your project sounds interesting and I hope it goes well.

In case you don’t have scoring and psychometric information about the IMMS, I am attaching a segment from my book. It will provide what you need. And, I am attaching some articles in case you haven’t seen them. If you come across anything else that might help you and have trouble obtaining it, let me know and I will send electronic copies if I have them.

Thanks for your comment about the Basho quote. I have liked it since I first became aware of it. There is another one in the signature below and it has a similar message.

I see that you are located in Gulfport. I am very familiar with the Gulfport exit on I-10. We have spent the night there more than once on our way to or from Brenham, TX, where one of our children and his family live.

Best wishes,
John

John M. Keller, Ph.D.
Professor Emeritus
Educational Psychology and Learning Systems
Florida State University

Official ARCS Model Website: http://arcsmodel.com
Professional Website: http://mailer.fsu.edu/~jkeller/JohnsHome/


"Do not seek to follow in the footsteps of the men of old. Seek what they sought."

Bashō (1644 – 1694)
Hi Dr. Keller,

I am a Microbiology and Anatomy and Physiology instructor at Mississippi Gulf Coast Community College in Gulfport, MS. I am also a Ph. D. candidate in the Science Education program at the University of Southern Mississippi in Hattiesburg, MS.

Your work is of the utmost interest to me both professionally and academically. I believe that your ARCS model and Instructional Materials Motivation Survey will be extremely beneficial to improve my teaching and my student’s learning. Furthermore, I am currently gathering and studying your work on motivation, and I would like your permission to use your IMMS as an instrument to collect data for purposes of my dissertation. I plan to investigate the effects of educational games on student motivation and achievement in a community college science class. I find your work fascinating and insightful, and I would be extremely excited to be able to use it in my dissertation.

On a lighter note …I like your quote, “Don’t imitate me; it’s as boring as the two halves of a melon.” However, I would really like to learn from you!!

Thanks for your time and consideration in this matter,

Kelly Rouse
Microbiology and A&P I and II Instructor
Mississippi Gulf Coast Community College-Jefferson Davis Campus
APPENDIX G

FLOW EXPERIENCE AND MOTIVATION QUESTIONNAIRE

<table>
<thead>
<tr>
<th>Identification number ___________________________ Topic __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please answer the following questions in relation to your experience in the event you have just completed. These questions relate to the thoughts and feelings you may have experienced during the event. There are no right or wrong answers. Think about how you felt during the event and answer the questions using the rating scale below.</td>
</tr>
<tr>
<td>Rating scale</td>
</tr>
<tr>
<td>1 = Strongly disagree</td>
</tr>
<tr>
<td>2 = Disagree</td>
</tr>
<tr>
<td>3 = Neither disagree nor agree</td>
</tr>
<tr>
<td>4 = Agree</td>
</tr>
<tr>
<td>5 = Strongly agree</td>
</tr>
</tbody>
</table>

**A. Flow antecedent**

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I was challenged, but I believed that my skills would allow me to meet the challenge.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. The game enabled the use of different playing strategies.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. I knew clearly what I wanted to do and achieve.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. I felt in total control of my playing actions.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. I was aware of how I was performing in the game.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. I understood the idea of the game.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>7. The goals of the game were clearly defined.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>8. I was not worried about my performance during playing.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>9. I could participate spontaneously without having thinking.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>10. The feedback the game provided was useful.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

**B. Flow experience**

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>During game-play, I felt:</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>11. During play, time seemed to alter (either speeded up or slowed down).</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>12. I really enjoyed the playing experience.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>13. My attention was focused entirely on playing the game.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>14. During play, I was not concerned with what others may have been thinking of my playing performance.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>15. I was totally immersed with playing the game</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
Please answer the following questions in relation to your experience in the event you have just completed. These questions relate to the thoughts and feelings you may have experienced during the event. There are no right or wrong answers. Think about how you felt during the event and answer the questions using the rating scale below.

**Rating scale**
1 = Strongly disagree  
2 = Disagree  
3 = Neither disagree nor agree  
4 = Agree  
5 = Strongly agree

**C. Intrinsic motivation**
16. In a class like this, I prefer course material that really challenges me so I can learn new things.
17. In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.
18. When I have the opportunity, I choose course assignments that I can learn from even if they don’t guarantee a good grade.

**D. Extrinsic motivation**
19. Getting a good grade in this class is the most satisfying thing to me.
20. If I can, I want to get better grades in this class than most of the other students.
21. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.
Dear Kelly,

I and Dr. Li-Chun Wang are pleased to share the questionnaire with you. We are attending ICALT conference in Rome and followed by another Doctoral Workshop in Athens. We shall be able to send you the questionnaire in late July. Let's keep in touch.

Best wishes,
Ming-Puu

------------------------------------------------------------------------
Ming-Puu Chen, Ph.D.
Professor & Chairperson
Graduate Institute of Information and Computer Education National Taiwan Normal

2012/7/5 kelly rouse <kelly.rouse@mgccc.edu>:
Hi Dr. Chen,

I thoroughly enjoyed reading your article "The effects of game strategy and preference-matching on flow experience and programming performance in game-based learning." I am a Ph.D. candidate at the University of Southern Mississippi, and I currently teach Microbiology at Mississippi Gulf Coast Community College in Gulfport, Mississippi-U.S. I find your work fascinating and extremely pertinent to my area of interest. Dr. Csikszentmihalyi's theory on Flow is phenomenal, and I am incorporating his theory into my dissertation. I will examine the effects of educational games on motivation and achievement in community college Microbiology classes.

I have found several Flow questionnaires, but I believe that your questionnaire is best suited for the purposes of my dissertation. I will modify it slightly for my project. I am asking for written permission to use this questionnaire in my dissertation. I am required by my Institutional Review Board to include written permission in order to include it. Is it possible for you to provide me with this?

Thanks for your time and consideration in this matter,

Kelly Rouse

Microbiology Instructor
Mississippi Gulf Coast Community College
APPENDIX I
PRETESTS/POSTTESTS FOR FOUR UNITS

Ch 24, 25

1. _____ is the name of the organism that causes syphilis.
   a. Neisseria gonorrhea
   b. Chlamydia trachomatis
   c. Treponema pallidum
   d. Human Papilloma

2. _____ is the name of the organism that causes gonorrhea.
   a. Neisseria gonorrhea
   b. Chlamydia trachomatis
   c. Herpes simplex
   d. Human Papilloma

3. _____ is the name of the organism that causes chlamydia.
   a. Neisseria gonorrhea
   b. Chlamydia trachomatis
   c. Herpes simplex
   d. Human Papilloma

4. _____ is a symptom of syphilis.
   a. Watery discharge
   b. Purulent discharge
   c. Gummus
   d. Painful blisters

5. _____ is a symptom of gonorrhea.
   a. Painful blisters
   b. Painless warts
   c. Frothy discharge
   d. Purulent discharge
6. _____ is the cause of genital herpes.
   a. Herpes simplex virus I
   b. Herpes simplex virus II
   c. Human Papilloma virus
   d. Candida albicans

7. _____ is a symptom of genital herpes.
   a. Painful blisters
   b. Painless warts
   c. Frothy discharge
   d. Purulent discharge

8. _____ is used to treat genital herpes.
   a. Penicillin
   b. Diflucan
   c. Gardasil
   d. Valtrex

9. _____ is the STD that is characterized by psychosis and rash on palms and soles.
   a. Herpes
   b. Syphilis
   c. Chlamydia
   d. Warts

10. _____ is the STD that is characterized by ectopic pregnancy.
    a. HIV
    b. Syphilis
    c. Chlamydia
    d. Herpes
1. _____is a specific part of the DNA that codes for a particular trait.
   a. Chromosome
   b. Chromatid
   c. Centromere
   d. Gene

2. _____are the building blocks of proteins
   a. Amino acids
   b. Teichoic acids
   c. Nucleic acids
   d. Peptic acid

3. _____is the base sequence that is ordered by ATCG during replication.
   a. ATCG
   b. AUCG
   c. TAGC
   d. UAGC

4. _____is the five carbon sugar found in DNA.
   a. Deoxyribose
   b. Maltose
   c. Ribose
   d. Sucrose

5. _____is the function of DNA ligase.
   a. Catalyze the phosphorylation of nucleotides
   b. Guide replication in the 5 prime to 3 prime direction
   c. Seal the gap between segments of DNA
   d. Serve as a primer for DNA replication
6. _____is the tRNA sequence that is ordered by a DNA sequence of GCTA.
   a. ATGC
   b. CGAU
   c. GCTA
   d. GCUA

7. _____is the role of tRNA.
   a. Carry amino acids to the ribosome
   b. Synthesize codons at the site of translation
   c. Synthesize the ribosome
   d. Transport DNA nucleotides to the ribosome

8. _____occurs in conjugation.
   a. Cells reproduce asexually
   b. DNA replication is stopped
   c. Genes are destroyed
   d. Plasmids are transferred to cells

9. _____is the percentage of cytosine that will be found in a DNA sample that contains 20% adenine.
   a. 10
   b. 30
   c. 40
   d. 50

10. _____is the mutation that occurs when DNA changes from GGCTAC to GGCCAC.
    a. Base substitution
    b. Deletion
    c. Inversion
    d. Transposition
1. _____is the organism that is commonly carried by cats.
   a. Ascaris
   b. *Bacillus cereus*
   c. Hookworms
   d. *Toxoplasma gondii*

2. _____are the bacteria that are commonly found in chickens.
   a. *E. coli*
   b. *Helicobacter pylori*
   c. Salmonella
   d. Shigella

3. _____are the organisms that carry malaria.
   a. Fleas
   b. Mosquitoes
   c. Pigs and bears
   d. Ticks

4. _____are the organisms that carry trichinella.
   a. Fleas
   b. Mosquitoes
   c. Pigs and bears
   d. Ticks

5. _____is a common symptom of Chagas.
   a. Diarrhea
   b. Discharge
   c. Megacolon
   d. Ulcer
6. _____ is the organism that causes Chagas.
   a. Helicobacter pylori
   b. Wuchereria bancrofti
   c. Trypanosoma brucei
   d. Trypanosoma cruzi

7. _____ are the organisms that carry Rocky Mountain Spotted Fever.
   a. Fleas
   b. Lice
   c. Mosquitoes
   d. Ticks

8. _____ are the organisms that carry E. coli and have been responsible for transmitting it to humans.
   a. Bears
   b. Chickens
   c. Cows
   d. Pigs

9. _____ is the name of the organism that causes ulcers.
   a. Ascaris lumbricoides
   b. Bacillus cereus
   c. Helicobacter pylori
   d. Salmonella typhi

10. _____ is a common symptom of elephantiasis.
    a. Diarrhea
    b. Discharge
    c. Itching
    d. Swollen extremities
Pretest/Posttest

Ch 13 and 21

1. _____is the name of the swine flu.
   a. H1N1
   b. H1N5
   c. H5NI
   d. H5N5

2. _____are the cause of the Bovine Spongiform Encephalopathy.
   a. Bacteria
   b. Helminths
   c. Prions
   d. Viruses

3. _____is the cause of AIDS.
   a. Herpes
   b. Human papilloma virus
   c. Human Immunodeficiency Virus
   d. Syphilis

4. _____is the drug of choice for treating MRSA.
   a. Bactrim
   b. Penicillin
   c. Tetracycline
   d. Vancomycin

5. _____is the drug of choice for treating VRSA
   a. AZT
   b. Doxycycline
   c. Zovirax
   d. Zyvox
6. _____ is a drug that causes permanently stained teeth when given to pregnant women or to children who have not yet formed permanent teeth.
   a. Bactrim
   b. Penicillin
   c. Tetracycline
   d. Zyvox

7. _____ is the drug of choice for anaerobic organisms such as *Helicobacter pylori* and *Trichomonas vaginalis*.
   a. Ciprofloxacin
   b. Doxycycline
   c. Flagyl
   d. Vancomycin

8. _____ is the cause of genital warts.
   a. *Candida albicans*
   b. Herpes
   c. Human Papilloma Virus
   d. Yeast

9. _____ is the mordant of the Gram stain.
   a. Alcohol
   b. Crystal violet
   c. Iodine
   d. Safranin

10. _____ is the counterstain of the Gram stain.
    a. Alcohol
    b. Crystal violet
    c. Iodine
    d. Safranin
APPENDIX J

WORKSHEETS FOR FOUR UNITS

Ch 24 & 25

STDs-Worksheet

Identification number___________________________

1. _____________________________is the name of the organism that causes syphilis.

2. _____________________________is the name of the organism that causes gonorrhea.

3. _____________________________is the name of the organism that causes chlamydia.

4. What are the symptoms of syphilis?

5. What are the symptoms of gonorrhea?

6. _____________________________is the cause of genital herpes.

7. _____________________________is the cause of genital warts.

8. What are the symptoms of genital herpes?

9. What are the symptoms of genital warts?

10. _____________________________is used to treat genital herpes.

11. _____________________________is an STD that is characterized by psychosis and rash on palms and soles.

12. Which STD is characterized by ectopic pregnancy?
13. Which STD is characterized by brown-green, frothy, foul smelling discharge?

14. Which STD is characterized by thick white discharge?
15. Which STD is characterized by painful blisters.

16. __________________________ is the treatment of choice for gonorrhea.

17. __________________________ is the treatment of choice for chlamydia.

18. __________________________ is the treatment of choice for syphilis.

19. __________________________ is the treatment of choice for herpes.

20. __________________________ is the treatment of choice for trichomoniasis.

21. Which STD is called the “CLAP”? 

22. Which STD is the most abundant in the state of Mississippi?

23. What did the “marriage blood test” detect in the state of Mississippi?

24. Approximately how many cases of Chlamydia were diagnosed in the state of Mississippi in 2011?

25. Which blood cells are greatly decreased in a person who has AIDS?
Ch 6 & 7
Genetics-Worksheet

Identification number____________________________________

1. TRUE or FALSE  An anticodon of ATG is complementary to a codon of UAC.

2. ____________________is a specific part of DNA that codes for particular traits.

3. ____________________is the structure of DNA.

4. ____________________is the sugar unit found in RNA.

5. In DNA, the hydrogen bonds connect ___________________to _____________________.

6. ____________________are building blocks of proteins.

7. List the two nucleic acids found in the body.
   a. ____________________
   b. ____________________

8. TRUE or FALSE- Spontaneous mutations occur in the natural course of microbial growth.

9. During replication, a DNA base sequence of ATCG will order a base sequence of _____________________.

10. Who discovered the shape of DNA in 1953?
    a. ____________________
    b. ____________________
    c. ____________________
    d. ____________________

11. ____________________is the five carbon sugar unit found in DNA.
12. List the two types of nitrogenous bases.
   a.
   b.

13. What is the function of DNA ligase?

14. A DNA sequence of GCTA will order a tRNA base sequence of ________________.

15. What is the role of tRNA?

16. List the four nitrogenous bases in DNA.
   a.
   b.
   c.
   d.

17. _________________is an abnormality of genetic information.

18. TRUE or FALSE-The anticodon is a base triplet on mRNA.

19. Define conjugation.

20. Who was awarded the Nobel Prize for the discovery of the structure of DNA?
   a.
   b.
   c.

21. In a sample of DNA, the concentration of adenine is 20%. The concentration of cytosine in this sample is _______percent. Show your work.
22. The formation of RNA from DNA which occurs in the nucleus is called ________________________.

23. A sample of DNA is 22 percent guanine. The percentage of thymine in this sample is _______________ percent. Show your work.

24. Define plasmids.

25. Define translation.

26. A base change in DNA of GGCTAC to GGCCAC is an example of a mutation called a ________________________.

27. The two strands of DNA double helix are ________________________, which means that they are aligned in opposite directions.


29. There are __________ types of tRNA.

30. List the two pyrimidines.
   a. 
   b.

31. ________________________ is the formation of protein by RNA on a ribosome.

32. Define semi-conservative replication.
Ch 8, 9, 11, 12

Prokaryotes and Eukaryotes-Worksheet

Identification number__________________________________________

1. Name an organism that is commonly found in cats.

2. Name an organism that is commonly found in chickens.

3. Name an organism that is commonly found in fleas.

4. Name an organism that is commonly found in ticks.

5. Give the symptoms for elephantiasis.

6. Give the symptoms for malaria.

7. Give the symptoms for yeast infection.

8. Give the symptoms for *Entamoeba histolytica*.

9. What organism carries malaria?

10. What organism carries *Toxoplasma gondii*?

11. What organism carries trichinella?

12. What organism carries *Wuchereria bancrofti*?

13. What are the symptoms of hookworm?

14. What are the symptoms of Chagas?

15. What organism causes Chagas?

16. What are the symptoms of bubonic plague?

17. What carries Rocky Mountain Spotted Fever?

18. What organism commonly carries *E. coli*?

19. Give the name of the organism that causes ulcers.

20. Give the name of the organism that causes Lyme disease.
Ch 13, 21

Viruses and Pharmacology-Worksheet

Identification number________________________

1. What is the purpose of the quadrant streak?

2. What is the name of the clear zone around the antibiotic disk of the Kirby Bauer method?

3. What is the purpose of the Kirby Bauer Method?

4. _______is the concentration of alcohol that is most effective in killing bacteria.

5. The stage should be ____________________ when starting to focus the microscope.

6. ____________________________ is the primary stain in the Gram stain method.

7. ____________________________ is the mordant in the Gram stain method.

8. ____________________________ is the decolorizer in the Gram stain method.

9. ____________________________ is the counter stain in the Gram stain method.

10. ____________________________ is the primary symptom of Ebola?

11. ____________________________ people were killed by the Flu of 1918 worldwide.

12. ____________________________ is the proper name for the swine flu.

13. ____________________________ is the cause of Bovine Spongiform Encephalopathy.

14. ____________________________ is the cause of AIDS.
15. ____________________________is the cause of genital warts.

16. ____________________________is the cause of rabies.

17. ____________________________is the drug of choice for MRSA?

18. ____________________________is the drug of choice for VRSA?

19. ____________________________is the drug that causes permanently stained teeth.

20. ____________________________is the drug of choice for *H. pylori* and *Trichomonas vaginalis*?
APPENDIX K

DEMOGRAPHIC INFORMATION

Identification number_________________

1. Gender
   a. Male  
   b. Female

2. Age range
   a. 18-24  
   b. 25-29  
   c. 30-40  
   d. 40+

3. Highest level of education
   a. Completed high school  
   b. Completed associate’s degree  
   c. Completed Bachelor’s degree  
   d. Completed GED

4. Enrollment
   a. Full time (12 or more hours)  
   b. Part time (less than 12 hours)  
   c. Only this class

5. Current educational status
   a. First semester  
   b. Second semester  
   c. Third semester  
   d. Fourth or more semester

6. Number of hours of work per week
   a. 1-10  
   b. 11-20  
   c. 20-30  
   d. 30+

7. How comfortable are you with using technology?
   a. Very comfortable  
   b. Comfortable  
   c. Uncomfortable  
   d. Very uncomfortable

8. Do you receive financial aid?
   a. Yes  
   b. No

9. Are you the primary care giver in the home? (For either children or parents)
   a. Yes  
   b. No

10. Approximately how many hours per week do you have available for studying for this course?
    a. 1  
    b. 2  
    c. 3  
    d. 4  
    e. 5 or more

11. Ethnicity:
    a. Caucasian  
    b. African American  
    c. Hispanic  
    d. Asian  
    e. Other
APPENDIX L

EDUCATIONAL GAMES FOR FOUR UNITS

Educational Game for Respiratory and Digestive Disorders
Sexually Transmitted Diseases
Ch 24 & 25

Kelly Rouse

Click to add notes
Educational Game for Genetics
Educational Game for Prokaryotes and Eukaryotes
Educational Game for Viruses and Pharmacology
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